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U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr'a
10^{9}	giga	G	jĭ'ga
10^{6}	mega	M	mĕg'a
10^{3}	kilo	k	kĭ'lo
10^{2}	hecto	h	hĕk'to
10	deka	da	dĕk'a
10^{-1}	deci	d	dĕs'i
10^{-2}	centi	c	sĕn'ti
10^{-3}	milli	m	mĭl'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	năn'o
10^{-12}	pico	p	pē'ko
10^{-15}	femto	f	fĕm'to
10^{-18}	atto	a	ăt'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
A	ampere(s)	
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps-2.22×10^{12} dpm
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	3.527×10^{-2} ounces= 2.205×10^{-3} pounds
Hz	hertz	cycle per second
kVp	kilovolt peak	
m	meter(s)	39.4 inches
m^3	cubic meter(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
mi	mile(s)	
ml	milliliter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g
s	second	

RADIATION DATA AND REPORTS

Volume 14, Number 8, August 1973

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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Published under the direction of

Dr. W. D. Rowe
Deputy Assistant Administrator
for Radiation Programs

Address correspondence to the Editor, *Radiation Data and Reports*, Office of Radiation Programs, Waterside Mall, E615, Washington, D.C. 20460.

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U.S. ENVIRONMENTAL PROTECTION AGENCY

John R. Quarles, Jr., Acting Administrator

The Potential Eye Exposure to Personnel Using Fluoroscopic Techniques[1]

H. D. Maillie, Ph.D.,[2] and W. D. Gregory, M.S.[3]

Measurements were made on a mockup to estimate the weekly exposure to the eyes of personnel working in the vicinity of a fluoroscope used in diagnostic radiology. A radiologist utilizing the image intensifier and protected by means of a lead drape and panel could receive 36 mR/week to the eyes, whereas other individuals positioned away from this area, but in the vicinity of the table, could receive up to 700 mR/week. The factors associated with these estimates, and the importance of wearing personnel monitors where they will estimate eye exposures are discussed.

Some confusion exists among personnel using fluoroscopic techniques as to the evaluation of the hazards associated with the use of such x-ray equipment. Many suggestions have been made as to where individuals should wear personnel monitoring devices. These have been summarized by Bushong (*1*) who concluded that if only one such device is supplied, it should be worn on the collar above the lead apron. The reason given was that this area received the highest percent of the appropriate maximum permissible dose equivalent (MPD).

An additional reason may be presented for agreement with this conclusion: this position, on the collar above the lead apron, represents the most convenient location for estimating the dose to the eyes. The dose to the lens of the eye legally fits into the definition of dose to the whole body (*2–4*).

Recent studies (*5,6*) have indicated that for a cardiac catheterization procedure, the eyes of an experienced cardiologist received an average exposure of 18 mR and the eyes of a senior resident, 30 mR. It is easily shown that even an experienced cardiologist working under the conditions specified, and not utilizing any eye protection, could perform only five catherizations per week and remain within the MPD for the lens of the eye.

There is evidence that similar types of eye exposures may exist with other fluoroscopic equipment (*7*), and with other methods.

Purpose of study

Scattered radiation measurements were made in the vicinity of a fluoroscope used in abdominal studies in diagnostic radiology. Such exposure rates were determined at eye level, and at positions known to be occupied by personnel during many fluoroscopic techniques. Knowing these exposure rates, and the estimated work load of the unit, estimates were made of the dose equivalent to the eyes of the people who occupy those locations.

Methods

A presswood phantom with a cross-section

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[1] This paper is based on work performed under contract with the U.S. Atomic Energy Commission at the University of Rochester Atomic Energy Project and has been assigned Report No. UR-3490-318.

[2] Dr. Maillie is associate professor of the Department of Radiation Biology and Biophysics, and director, Health Physics Division, University of Rochester School of Medicine and Dentistry, Rochester, N.Y. 14642.

[3] Mr. Gregory is health physicist of the Health Physics Division, University of Rochester School of Medicine and Dentistry, Rochester, N.Y. 14642.

of 12 by 12 inches and a thickness of 7¾ inches was placed in the beam on the fluoroscopy table. The image intensifier was lowered to a point above the phantom which would approximate its location when a patient study was performed. The beam size was set at its largest value under these conditions (i.e., the largest area which would not exceed the area of the image intensifier screen). The unit was operated at 120 kVp and 1.0 mA. The unit was operated under conditions similar to those used during a fluoroscopic procedure, in particular, a lead drape covering the area between the image intensifier and the table top was in place and a lead panel was lifted into place along the length of the table. It was felt that this set of conditions tended to maximize the scattered radiation which was likely to be seen in the normal use of this unit.

Figure 1 shows the floor plan of this unit, and the locations (A–E) which are known to be occupied by personnel working in this room during fluoroscopic techniques. Scattered radiation measurements were made at these positions. Such measurements were made at a height of 5 feet above floor level in an effort to approximate eye level.

The work loads and other factors were estimated by the technologist in charge of the room, and were stated to be:

1. straight fluoroscopy (95 to 110 kVp at 2 mA)—660 mA-min/week,
2. 70 mm (100 to 120 kVp at 200 mA)—1,400 mA-s/week, and
3. spot films (75 to 110 kVp at 200 mA)—15,000 mA-s/week.

These work loads were used in estimating the weekly dose equivalent to the positions studied.

Scattered radiation measurements were made with either a Victoreen Model 440 survey meter or an Eberline Model RO–1 Rad Owl survey meter. If used properly, either instrument is energy independent for the photons measured in this study. All readings in mR/h were converted to mR/mA-s or mR/mA-min as required.

Results

The scattered radiation measurements made at eye level at each of the locations studied are presented in table 1. Also presented in table 1 are the estimated dose equivalents which are based upon the exposure rates and the given work loads for all related fluoroscopic procedures.

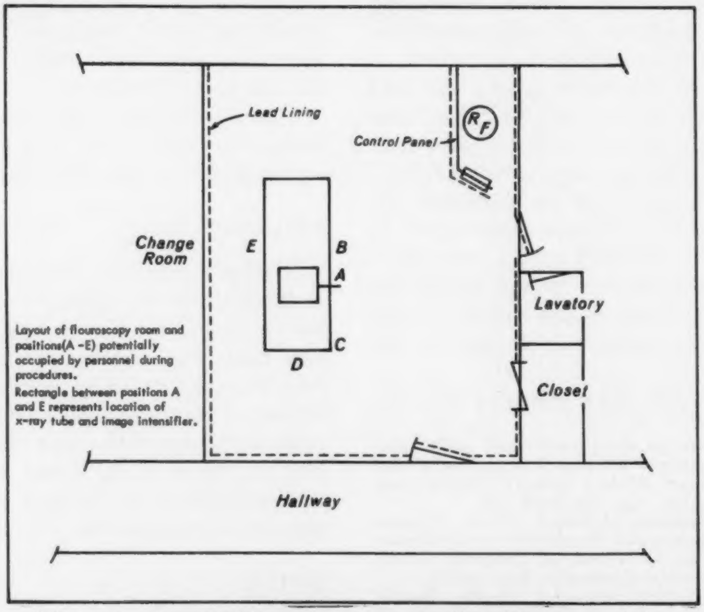

Figure 1. Layout of fluoroscopy room and positions potentially occupied by personnel during procedures

Table 1. Eye level scattered radiation measurements and weekly dose equivalents

Position	Exposure (mR/h)	Dose equivalent (mrem/week)
A	2.3	36
B	20	310
C	30	470
D	45	700
E	35	550

Note the different exposure rates associated with the various positions. Due to the lead drape and the location of the image intensifier some shielding is afforded location A. Location B also shows some lesser degree of shielding. But the remaining positions are out of the "shadow" of the image intensifier and, hence, are subjected to unattenuated scattered radiation.

It should be noted that similar measurements and calculations were also made at trunk (waist) level and were corrected for lead apron attenuation. As expected, these body measurements were much lower than the eye level dose equivalents given above.

Discussion

It should be recognized that the dose-equivalents given above are only representative of the dose to the eyes which would be received by personnel using this particular unit. It is unlikely that any one person would occupy a given position for the full operating time of this unit during a week. It is also true that many individuals (residents and student technologists) rotate through the department and will, therefore, not work in this particular room for a full year.

However, in those cases where there is no rotation of personnel because of limited staff (e.g., small hospitals or private offices) it is possible that dose equivalents to the lens of the eye may exceed 5 rem per year. For example, consider a technologist who occupies position C throughout one-fourth of the operating time for fluoroscopic procedures. With no eye protection and with 1 month's vacation, this person could receive 5,600 mrem in 1 year.

This is not unexpected when compared with the data of Malsky, et al. (*6*). Assume that a cardiologist receives an average of 18 mR to the eyes for a single full cardiac procedure. Let it be assumed that 10 such patients are handled each week. This could result in an average eye exposure to the cardiologist of 180 mR per week (assuming that the same individual performed all catheterizations). This would result in a yearly exposure of 8,600 mrem. Again, it is not stated that this is the dose received by the lenses of this individual. Many factors could change the actual dose. For example, it may be demonstrated that wearing glasses can reduce the exposure to the eyes of people working in fluoroscopy (*8*).

A more recent study (*9*) has indicated much lower exposures for cardiac procedures than those reported by Malsky, et al. This points out the advisability of measuring eye level exposures with personnel monitors under actual conditions.

The question must also be asked as to whether this level of radiation dose from diagnostic energies of x rays would be sufficient to produce an effect in the eyes of individuals so exposed. The National Academy of Sciences Advisory Committee on the biological effects of ionizing radiations (the Beir Committee) suggests a high threshold dose for cataract formation (1,000 rads or more when delivered over a period of months), but does admit that studies with mice may indicate a lower threshold for lens opacities in that species (*10*).

Recent studies on lens changes brought about by protons and x rays on rabbits have also indicated a lower threshold dose particularly with radiations having LET's approaching those of diagnostic x-ray photons (*11*).

Many people working in fluoroscopy wear their film badges under the lead apron. Indeed many technologists have been trained to wear their badges in such locations (*12*). This is understandable since much emphasis has been placed upon the genetic effects of ionizing radiations.

It is felt that, until it can be established that a high threshold dose does exist for the radiation production of lens opacities in man, steps should be taken to prevent exposures to the eyes in excess of MPD. This may be accomplished by reducing the exposure time of personnel in the fluoroscopy room or providing

some degree of eye shielding. It is also felt that every effort should be made to measure eye exposures under actual working conditions. If necessary, two dosimeters should be worn; one at eye level and one at waist level under the apron.

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Data

SECTION I. MILK AND FOOD

Milk Surveillance, April 1973

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 16 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—7 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radio-

Figure 1. Milk sampling networks in the Western Hemisphere

strontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 $\pm$ 0.08 g/liter for calcium and 1.51 $\pm$ 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during June 1972 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 18 laboratories producing data for the network reports in *Radiation Data and Reports*, 14 participated in the study.

The accuracy results of this study for these 14 laboratories are shown in table 1. The accuracy of the cesium-137 measurements continues to be excellent as in previous experiments. However, both the accuracy and precision need to be improved for iodine-131, strontium-89, and strontium-90 which could probably be accomplished through recalibration.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addi-

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category				Experimental 2σ error (pCi/liter)
	Acceptable [a]	Warning level [b]	Unacceptable [c]	Total	
Iodine-131 (96 or 99 pCi/liter)	7 (58%)	1 (8%)	4 (33%)	12	6
Iodine-131 (438 or 484 pCi/liter)	11 (85%)	0	2 (15%)	13	25 or 28
Cesium-137 (53 or 54 pCi/liter)	11 (92%)	0	1 (8%)	12	6
Cesium-137 (295 or 303 pCi/liter)	11 (85%)	2 (15%)	0	13	17
Strontium-89 (29 or 30 pCi/liter)	9 (82%)	0	2 (18%)	11	6
Strontium-89 (197 or 201 pCi/liter)	3 (33%)	1 (11%)	5 (56%)	9	11 or 12
Strontium-90 (32.1 or 32.4 pCi/liter	4 (33%)	4 (33%)	4 (33%)	12	1.9
Strontium-90 (150.5 or 151.2 pCi/liter)	6 (55%)	0	5 (45%)	11	8.7

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

tion, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*6*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*6*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≧ 50 pCi-liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≧ 20 pCi/liter;
Iodine-131, Cesium-137, Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≧ 100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the February 1973 issue of *Radiation Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported in *Radiation Data and Reports.* The relationship between the PMN stations and the State stations is shown

Table 2. Concentrations of radionuclides in milk for April 1973 and 12-month period, May 1972 through April 1973

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Ala:	Montgomery [c]	P	5	5	12	6
Alaska:	Palmer [c]	P	4	4	0	2
Ariz:	Phoenix [c]	P	0	0	0	0
Ark:	Little Rock [c]	P	9	9	12	3
Calif:	Sacramento [c]	P	2	1	0	0
	San Francisco [c]	P	0	0	0	0
	Del Norte	P	14	11	0	7
	Fresno	P	0	1	0	2
	Humboldt	P	4	3	0	2
	Los Angeles	P	2	1	0	2
	Mendocino	P	3	2	0	4
	Sacramento	P	2	2	0	3
	San Diego	P	2	1	0	3
	Santa Clara	P	0	2	0	2
	Shasta	P	2	2	0	5
	Sonoma	P	3	2	0	3
Colo:	Denver [c]	P	3	3	0	0
	East	R	NS	NA	NS	7
	Northeast	R	NS	NA	NS	1
	Northwest	R	NA	NA	[d] 0 (2)	0
	South Central	R	NS	NS	NS	
	Southeast	R	NA	NA	NS	0
	Southwest	R	NA	NA	[d] 0	2
	West	R	NA	NA	NS	3
Conn:	Hartford [c]	P	4	5	0	3
	Central	P	NA		NA	
Del:	Wilmington [c]	P	3	7	0	7
D.C:	Washington [c]	P	2	5	0	3
Fla:	Tampa [c]	P	4	4	33	33
	Central	R	5	5	23	38
	North	R	8	6	23	14
	Northeast	R	6	5	29	32
	Southeast	R	6	5	28	46
	Tampa Bay area	P	5	5	43	34
	West	R	7	8	0	9
Ga:	Atlanta [c]	P	NS	8	0	9
Hawaii:	Honolulu [c]	P	0	1	0	0
Idaho:	Idaho Falls [c]	P	0	3	0	0
Ill:	Chicago [c]	P	3	5	0	4
Ind:	Indianapolis [c]	P	5	4	0	1
	Central	P	6	7	10	9
	Northeast	P	4	6	10	8
	Northwest	P	6	8	15	10
	Southeast	P	6	7	0	7
	Southwest	P	7	7	0	10
Iowa:	Des Moines [c]	P	5	5	0	0
	Iowa City	P	5	6	0	5
	Des Moines	P	5 (2)	5	0 (2)	3
	Little Cedar	P	NS	4	0	2
	Spencer	P	7	6	0	3
Kans:	Wichita [c]	P	4	5	0	0
	Coffeyville	P	7	8	9	9
	Dodge City	P	3	5	4	5
	Falls City, Nebr	P	NS	-	NS	-
	Hays	P	6	9	7	7
	Kansas City	P	4	8	7	8
	Topeka	P	5	7	5	5
	Wichita	P	6	8	11	10
Ky:	Louisville [c]	P	4	6	0	2
La:	New Orleans [c]	P	11	11	0	1
Maine:	Portland [c]	P	0	5	16	19
Md:	Baltimore [c]	P	4	6	12	4
Mass:	Boston [c]	P	6	6	11	13
Mich:	Detroit [c]	P	6	6	13	5
	Grand Rapids [c]	P	6	7	0	1
	Bay City	P	14	5	0 (2)	2
	Charlevoix	P	8	5	0 (4)	6
	Detroit	P	6	4	0	3
	Grand Rapids	P	7	5	0	4
	Lansing	P	10	4	0 (2)	5
	Marquette	P	8	5	17 (2)	12
	Monroe	P	5	3	0 (2)	1
	South Haven	P	7	5	0 (4)	6
Minn:	Minneapolis [c]	P	6	7	0	9
	Bemidji	P	5	6	15	13
	Duluth	P	16	15	24	24
	Fergus Falls	P	7	7	15	11
	Little Falls	P	12	17	10	37
	Mankato	P	4	5	0	0
	Marshall	P	0	4	0	0

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for April 1973 and 12-month period, May 1972 through April 1973—continued

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:—continued						
Minn:	Minneapolis	P	9	9	15	13
	Rochester	P	7	7	20	0
Miss:	Jackson [c]	P	8	8	14	8
Mo:	Kansas City [c]	P	5	5	0	0
	St. Louis [c]	P	8	6	0	1
Mont:	Helena [c]	P	4	4	0	0
Nebr:	Omaha [c]	P	5	4	0	0
Nev:	Las Vegas [c]	P	2	1	0	0
N.H:	Manchester [c]	P	4	6	12	14
N.J:	Trenton [c]	P	6	6	0	5
N. Mex:	Albuquerque [c]	P	0	0	0	0
N.Y:	Buffalo [c]	P	4	5	12	4
	New York City [c]	P	4	8	0	4
	Syracuse [c]	P	5	6	0	3
	Albany	P	2	4	0 (4)	0
	Buffalo	P	6	5	0	0
	Massena	P	4	7	0	0
	New York City	P	NA	6	0	0
	Syracuse	P	12	5	0	0
N.C:	Charlotte [c]	P	6	7	12	5
N. Dak:	Minot [c]	P	6	8	0	2
Ohio:	Cincinnati [c]	P	4	5	0	2
	Cleveland [c]	P	6	6	0	3
Okla:	Oklahoma City [c]	P	3	4	0	1
Oreg:	Portland [c]	P	4	4	0	3
	Baker	P	NA		0	2
	Coos Bay	P	NA		12	7
	Eugene	P	NA		0	0
	Medford	P	NA		13	9
	Portland composite	P	NA		0	2
	Portland local	P	NA		0	1
	Redmond	P	NA		11	3
	Tillamook	R	NA		21	12
Pa:	Philadelphia [c]	P	5	6	0	3
	Pittsburgh [c]	P	8	8	0	6
	Dauphin	P	6		0	4
	Erie	P	NS		NS	3
	Philadelphia	P	NS		NS	6
	Pittsburgh	P	NS		NS	5
R.I:	Providence [c]	P	5	5	0	10
S.C:	Charleston [c]	P	6	7	0	8
	Chapin	R	NS	8	NS	14
	Clemson	R	8	8	8	8
	Columbia	R	9	9	13	13
	Fairfield	R	NS	6	NS	18
	Hartsville–02	R	7	6	15	15
	Hartsville–03	R	NS	17	NS	18
	Lee County	R	7	8	20	19
	Oconee County	R	NS	8	NS	12
	Pickens	R	NS	7	NS	13
	Williston	R	NS	8	NS	15
	Winnsboro	R	NS	9	NS	30
S. Dak:	Rapid City [c]	P	4	5	0	1
Tenn:	Chattanooga [c]	P	7	8	0	6
	Memphis [c]	P	5	6	0	1
	Chattanooga	P	NA	9	0	7
	Clinton	R	NA	8	9 (2)	8
	Fayetteville	R	NA	8	18 (2)	7
	Kingston	R	NA	8	0	2
	Knoxville	P	NA	7	0 (2)	3
	Lawrenceburg	R	NS	6	NS	8
	Nashville	P	4	7	0	4
	Pulaski	R	NA	6	0 (2)	5
	Sequoyah	R	NS	7	NS	13
Tex:	Austin [c]	P	0	2	0	0
	Dallas [c]	P	5	5	0	0
	Amarillo	R	NA		NA	
	Corpus Christi	R	NA		NA	
	El Paso	R	NA		NA	
	Fort Worth	R	NA		NA	
	Harlingen	R	NA		NA	
	Houston	R	NA		NA	
	Lubbock	R	NA		NA	
	Midland	R	NA		NA	
	San Antonio	R	NA		NQ	
	Texarkana	R	NA		NA	
	Uvalde	R	NA		NA	
	Wichita Falls	R	NA		NA	

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for April 1973 and 12-month period, May 1972 through April 1973—continued

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Utah:	Salt Lake City [c]	P	0	3	0	2
Vt:	Burlington [c]	P	4	5	11	8
Va:	Norfolk [c]	P	5	6	0	5
Wash:	Seattle [c]	P	2	4	0	1
	Spokane [c]	P	6	4	0	2
	Benton County	R	NS	1	NS	0
	Franklin County	R	0	1	0	0
	Longview	R	3	4	11	2
	Sandpoint, Idaho	R	6	7	0	5
	Skagit County	R	3	7	0	4
W. Va:	Charleston [c]	P	6	7	0	3
Wisc:	Milwaukee [c]	P	5	5	0	5
Wyo:	Laramie [c]	P	3	2	0	0
CANADA:						
Alberta:	Calgary	P	NA		10	12
	Edmonton	P	NA		15	17
British Columbia:	Vancouver	P	NA		16	17
Manitoba:	Winnipeg	P	NA		7	13
New Brunswick:	Moncton	P	NA		6	8
Newfoundland:	St. John's	P	NA		15	22
Nova Scotia:	Halifax	P	NA		17	13
Ontario:	Ottawa	P	NA		4	8
	Sault Ste. Marie	P	NA		15	19
	Thunder Bay	P	NA		18	17
	Toronto	P	NA		2	8
	Windsor	P	NA		3	7
Quebec:	Montreal	P	NA		11	8
	Quebec	P	NA		15	16
Saskatchewan:	Regina	P	NA		15	10
	Saskatoon	P	NA		6	10
CENTRAL AND SOUTH AMERICA:						
Canal Zone:	Cristobal [c]	P	0	1	0	15
Chile:	Santiago	P	0	1	0	1
Colombia:	Bogota	P	0	0	0	0
Ecuador:	Guayaquil	P	0	0	0	0
Jamaica:	Kingston	P	0	2	21	49
Puerto Rico:	San Juan [c]	P	3	1	0	2
Venezuela:	Caracas	P	0(2)	0	6(2)	1
PMN network average [e]			4	5	3	4

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] The practical reporting level for this network differs from the general ones given in the text. Sampling results for these networks were equal to or less than the following practical reporting levels:
Cesium-137: Colorado—25 pCi/liter.

[e] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

in figure 2. The first column in table 2 under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples

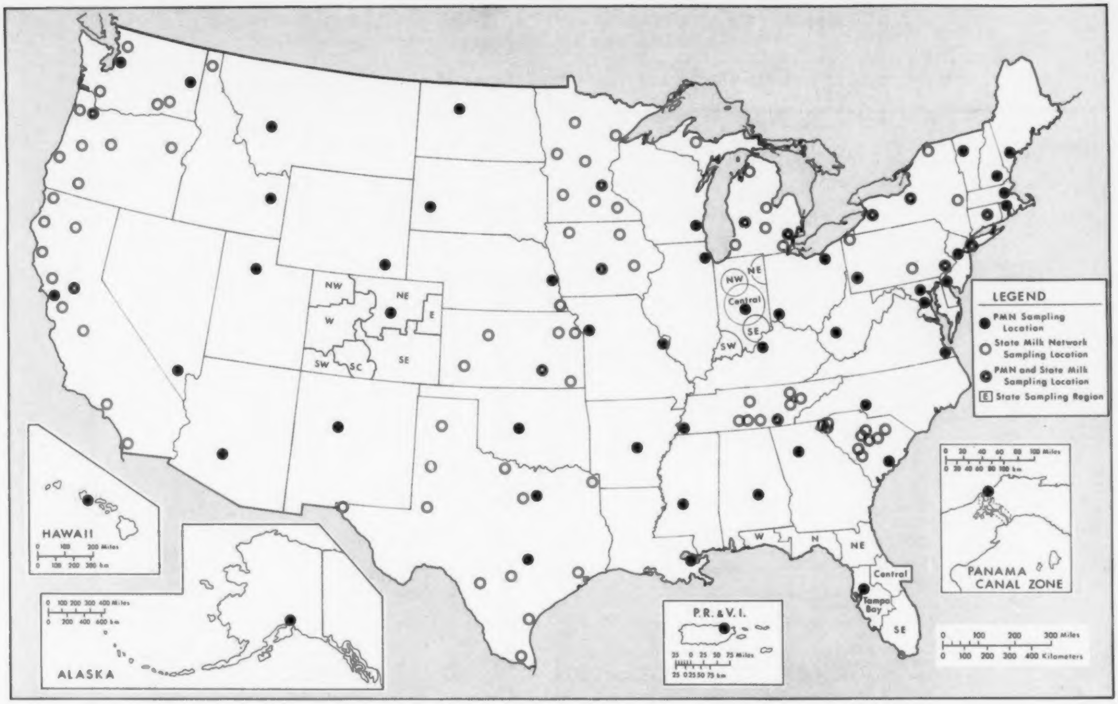

Figure 2. State and PMN milk sampling stations in the United States

greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for April 1973 and the 12-month period, May 1972 to April 1973. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from table 2 since levels at all stations for April 1973 were below the respective practical reporting levels.

Strontium-90 monthly averages ranged from 0 to 16 pCi/liter in the United States for April 1973 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn; and Hartsville, S.C.[1]) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 43 pCi/liter in the United States for April 1973, and the highest 12-month average was 46 pCi/liter (Southeast Florida) representing 1.3 percent of the value derived from the recommendations given in the Federal Radiation Council report.

[1] Average of 5 months.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data from their milk surveillance networks:

Bureau of Radiological Health
Environmental Health & Consumer Protection Program
California Department of Public Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Division of Radiological Health
South Carolina State Board of Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

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Milk Surveillance Network, February 1973

National Environmental Research Center—
Las Vegas, Environmental Protection Agency

The Milk Surveillance Network operated by the NERC-LV consists of 24 routine and two alternate sampling locations (figure 1) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site (NTS).[1]

In the event of a release of radioactivity from the NTS, special sampling within the affected

[1] This network is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

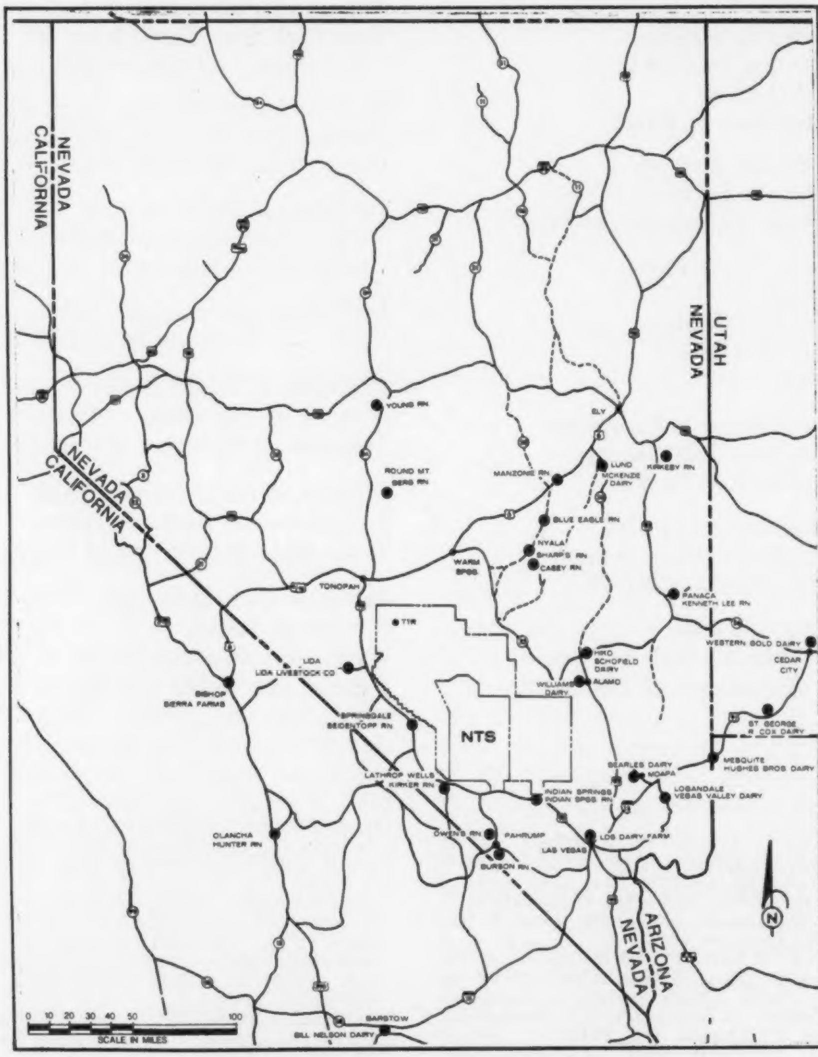

Figure 1. NERC–LV milk surveillance network

area is conducted to determine radionuclide concentrations and to take protective action, if required. Additional milk sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and analytical procedures was included with the milk results reported in the July 1973 issue of *Radiation Data and Reports.*

Results

The analytical results of all milk samples collected in February 1973 by NERC-LV surveillance programs are listed in table 1. With the exception of cesium-137 at levels near the minimum detectable activity (MDA) of 10 pCi/liter, no gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in February. Levels of tritium near the MDA for this radionuclide (200 pCi/liter) were also measured by radiochemistry analyses. The highest concentration of tritium during February was 490 ± 260 pCi/liter. In order to economize operations, the frequency of strontium-89 and strontium-90 analysis on routine samples was changed from

Table 1. Milk surveillance results, February 1973

Location	Date collected	Sample type [a]	Radionuclide concentrations [b] (pCi / liter)			
			Cesium-137	Strontium-89	Strontium-90	Tritium
California:						
Bishop:						
Sierra Farms	2/2	11	10	NA	NA	NA
Hinkley:						
Bill Nelson Dairy	2/1	12	[c] <100	NA	NA	NA
Olancha:						
Hunter Ranch	2/2	13	[c] <100	NA	NA	NA
Nevada:						
Alamo:						
Williams Dairy	2/5	12	<10	NA	NA	NA
Austin:						
Young's Ranch	2/5	13	<10	NA	NA	470 ± 240
Currant:						
Blue Eagle Ranch	NS					
Manzonie Ranch	2/7	13	<10	NA	NA	NA
Hiko:						
Schofield Dairy	2/5	12	<10	NA	NA	<230
Indian Springs:						
Indian Springs Ranch	2/14	13	<10	NA	NA	NA
Las Vegas:						
LDS Dairy Farms	2/9	12	<10	NA	NA	<230
Lathrop Wells:						
Kirker Ranch	2/13	13	<10	NA	NA	NA
Lida:						
Lida Livestock Company	2/4	13	[c] <100	NA	NA	NA
Logandale:						
Vegas Valley Dairy	2/7	12	<10	NA	NA	NA
Lund:						
McKenzie Dairy	2/8	12	<10	NA	NA	<230
Mesquite:						
Hughes Bros. Dairy	2/5	12	<10	NA	NA	420 ± 260
Moapa:						
Searles Dairy	2/7	12	<10	NA	NA	NA
Nyala:						
Sharp's Ranch	2/8	13	[c] <100	<2	5.0 ± 1.4	490 ± 260
Pahrump:						
Owens Ranch	2/14	13	<10	NA	NA	NA
Panaca:						
Kenneth Lee Ranch	2/4	13	<10	NA	NA	NA
Round Mountain:						
Berg Ranch	2/5	13	<10	NA	NA	NA
Shoshone:						
Kirkeby Ranch	2/9	13	<10	NA	NA	NA
Springdale:						
Seidentopf Ranch	2/13	13	<10	NA	NA	NA
Utah:						
Cedar City:						
Western Gold Dairy	2/6	12	<10	NA	NA	NA
St. George:						
R. Cox Dairy	2/5	12	<10	NA	NA	NA

[a] 11—Pasteurized milk.
12—Raw milk from Grade A producer(s).
13—Raw milk from family cow(s).
[b] Two-sigma counting error provided when available.
[c] Small sample size increased minimum detectable activity.
NA, no analysis.
NS, no sample.

monthly to quarterly effective January 1, 1973. Because the sample collected at Nyala, Nev. in January was sour, the February sample was analyzed. The concentrations of strontium-89 and strontium-90 for this sample were <2 and 5.0 ± 1.4 pCi/liter, respectively.

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intake of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	January–June 1971	December 1972
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Institutional Diet Samples	April–June 1972	July 1973
Radiostrontium in Milk	January–December 1971	November 1972
Strontium-90 in Tri-City Diets	January–December 1971	December 1972

Radionuclides in Institutional Diet Samples July–September 1972

Environmental Protection Agency and Food and Drug Administration

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiological surveillance and assessment. Recognizing that the diet is a potentially significant contribution to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. The program is now administered by the Office of Radiation Programs, Environmental Protection Agency with the assistance of the Office of Food Sanitation, Food and Drug Administration, Department of Health, Education and Welfare (*1*).

This program estimates the dietary intake of radionuclides in a selected population group, ranging from children to young adults of school age. At present 26 institutions—distributed geographically as shown in figure 1—are being sampled. Previous results showed that the daily

Figure 1. Institutional diet sampling locations as of September 1972

dietary intake of teenage girls and children from 9 to 12 years of age were comparable, but teenage boys consumed 20 percent more food per day (*1,2*). Extrapolating this information, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intake of children.

The sampling procedure is generally the same at each institution. Each sample represents the edible portion of the diet for a full 7-day week (21 meals plus between-meal snacks), obtained by duplicating the food intake of a different individual daily. Drinking water—which is not included—is also sampled periodically. Each daily sample is kept frozen until the end of the collection period. It is then packed in dry ice and shipped by air to either the National Environmental Research Center, Las Vegas, Nev. or the Eastern Environmental Radiation Facility, Montgomery, Ala. A detailed description of sampling and analytical procedures has already been presented in *Radiological Health Data and Reports* (*3*).

Results

Table 1 shows the analytical results for institutional diet samples collected from all stations during July–September 1972. The stable elements, calcium and potassium, are reported in g/kg of diet. Where applicable, radionuclide concentrations of these samples reported in pCi/kg of diet are corrected for radioactive decay to the midpoint of the sample collection period. Dietary intakes in g/day or pCi/day were obtained by multiplying the food consumption rate in kg/day by the appropriate concentration values. The average food consumption rate during this period was 1.68 kg/day compared to the network average of 1.85 kg/day observed from 1961 through 1971.

Strontium-90 dietary intake averaged 9 pCi/day during this period. Cesium-137 intake averaged 4 pCi/day. These results fall within Range I as defined by the former Federal Radiation Council (*4*). Barium-140 and iodine-131 concentrations were below detectable levels.

Table 1. Concentration and intake of stable elements and radionuclides in institutional total diets of children July–September 1972

Location of institution		Month [a] (1972)	Total weight (kg/day)	Calcium		Potassium		Strontium-90		Cesium-137	
				(g/kg)	(g/day)	(g/kg)	(g/day)	(pCi/kg)	(pCi/day)	(pCi/kg)	(pCi/day)
Alaska:	Juneau	July	1.42	0.8	1.1	1.6	2.3	4	5	14	20
	Palmer	Aug [b]	1.84	.5	1.0	1.7	3.1	5	10	0	0
Ariz:	Phoenix	July	1.51	.4	.7	2.0	3.0	4	6	0	0
Ark:	Little Rock	July	1.36	.5	.6	1.6	2.2	9	12	0	0
Calif:	Los Angeles		NS								
	San Francisco	July [b]	1.85	.6	1.1	1.7	3.1	4	7	0	0
Del:	Wilmington	July [b]	.82	.8	.7	1.4	1.2	5	4	0	0
Fla:	Tampa	Sept	1.80	.7	1.2	1.4	2.6	6	10	24	43
Hawaii:	Honolulu	July	2.17	.5	1.1	1.7	3.7	3	7	0	0
Idaho:	Idaho Falls	July [b]	1.69	.6	1.0	1.6	2.6	7	12	11	19
Ill:	Chicago		NS								
Ky:	Louisville	July [b]	2.70	.9	2.4	1.6	4.3	7	19	0	0
La:	New Orleans	July [b]	1.35	.6	.9	1.8	2.4	8	11	0	0
Mass:	Boston	July [b]	2.56	.6	1.5	1.2	3.2	5	13	0	0
Mo:	St. Louis	July	.84	.5	.4	2.1	1.8	4	4	0	0
Nebr:	Omaha	July [b]	1.71	.5	.8	1.8	3.0	6	11	0	0
Nev:	Carson City	July	1.22	.7	.8	1.7	2.1	2	3	0	0
N. Mex:	Albuquerque	Aug [b]	1.91	.6	1.1	1.8	3.4	4	8	0	0
Ohio:	Cleveland	Sept [b]	.66	.5	.3	1.2	.8	6	4	0	0
Oreg:	Portland	July [b]	2.01	.4	.8	1.7	3.4	8	17	0	0
Pa:	Pittsburgh	July	3.19	.5	1.7	1.3	4.3	7	22	0	0
S.C:	Charleston	July [b]	1.82	.7	1.3	1.3	2.4	7	12	11	20
S. Dak:	Sioux Falls	July [b]	1.10	.6	.7	1.4	1.5	9	10	0	0
Tex:	Austin	July [b]	1.17	.6	.8	1.1	1.3	3	4	0	0
Utah:	Salt Lake City	July [b]	1.95	.4	.7	1.9	3.7	4	8	0	0
Wash:	Seattle	July [b]	1.78	.5	.9	1.8	3.1	0	0	0	0
Institutional average			1.68	0.6	1.0	1.6	2.7	5	9	3	4

[a] Quarterly sample usually collected the first month of the quarter.
[b] Food samples were collected from two or more children who were not between the ages of 9 and 12.
NOTE: Iodine-131 and barium-140 were not detected at any station during this period. Juneau, Alaska, had a strontium-89 concentration of 6 pCi/kg or 9 pCi/day and Seattle, Wash., had a strontium-89 concentration of 7 pCi/kg or 12 pCi/day.
NS, no sample.

Strontium-89 was detected in Juneau, Alaska, and Seattle, Wash.

All concentrations less than or equal to the appropriate minimum detectable level have been reported as zero. The minimum detectable concentration is defined as the measured concentration equal to the 2 standard-deviation analytical error. Accordingly, the minimum detectable limits are strontium-89, 5 pCi/kg; strontium-90, 2 pCi/kg; iodine-131, 10 pCi/kg; barium-140, 10 pCi/kg; cesium-137, 10 pCi/kg.

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Recent coverage in *Radiation Data and Reports:*

Period	Issue
July–September 1971	April 1972
October–December 1971	June 1972
January–March 1972	June 1973
April–June 1972	July 1973

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence [1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
California	January–December 1970	June 1972
Colorado River Basin	1968	March 1972
Community Water Supply Study	1969	September 1972
Florida	1969	January 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1971	February 1973
Minnesota	July 1970–June 1971	November 1972
North Carolina	1968–1970	September 1972
Radiostrontium in Tap Water, *HASL*	July–December 1971	November 1972
Tritium Surveillance	January–March 1973	July 1973
U.S. Surface Waters	January 1969–December 1970	July 1973

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Water Surveillance Programs February 1973 and 1972 Special Analyses

National Environmental Research Center—Las Vegas, Environmental Protection Agency

The Water Surveillance Network,[1] operated by the National Environmental Research Center—Las Vegas (NERC-LV), consists of 61 sampling locations (figures 1 and 2) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing programs sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site.

[1] This network is operated under a Memorandum of Understanding (No. AT (26–1)–539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

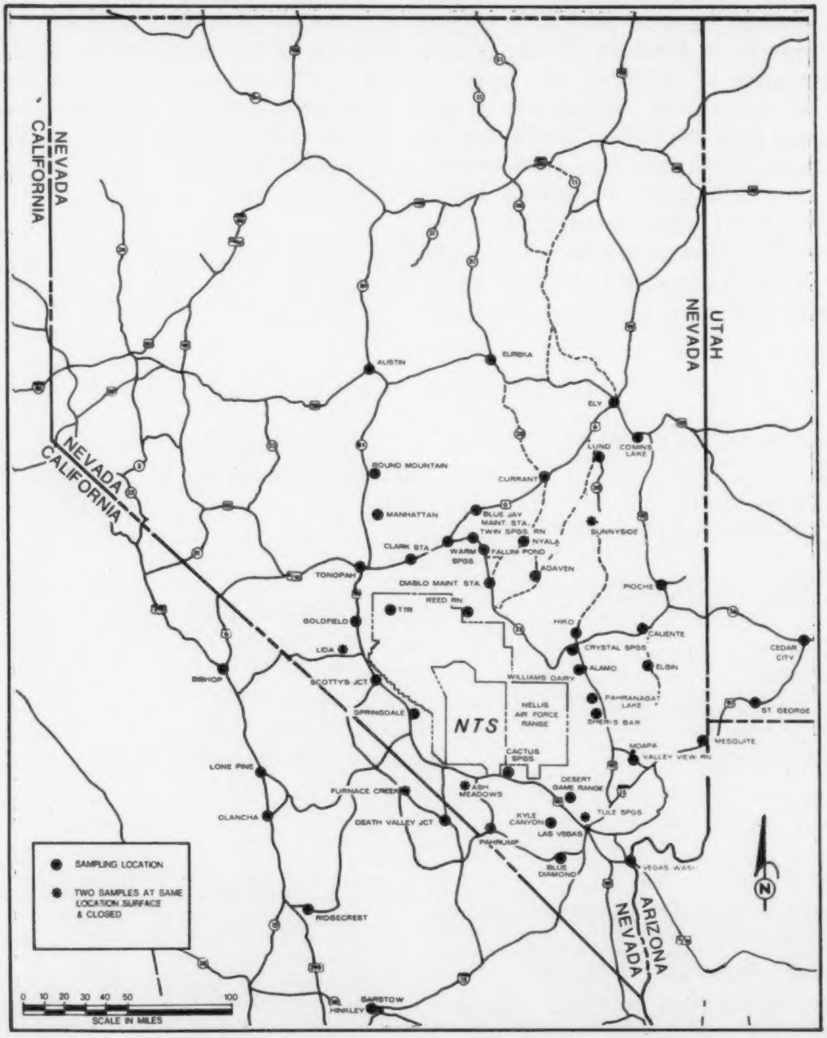

Figure 1. NERC–LV Water Surveillance Network

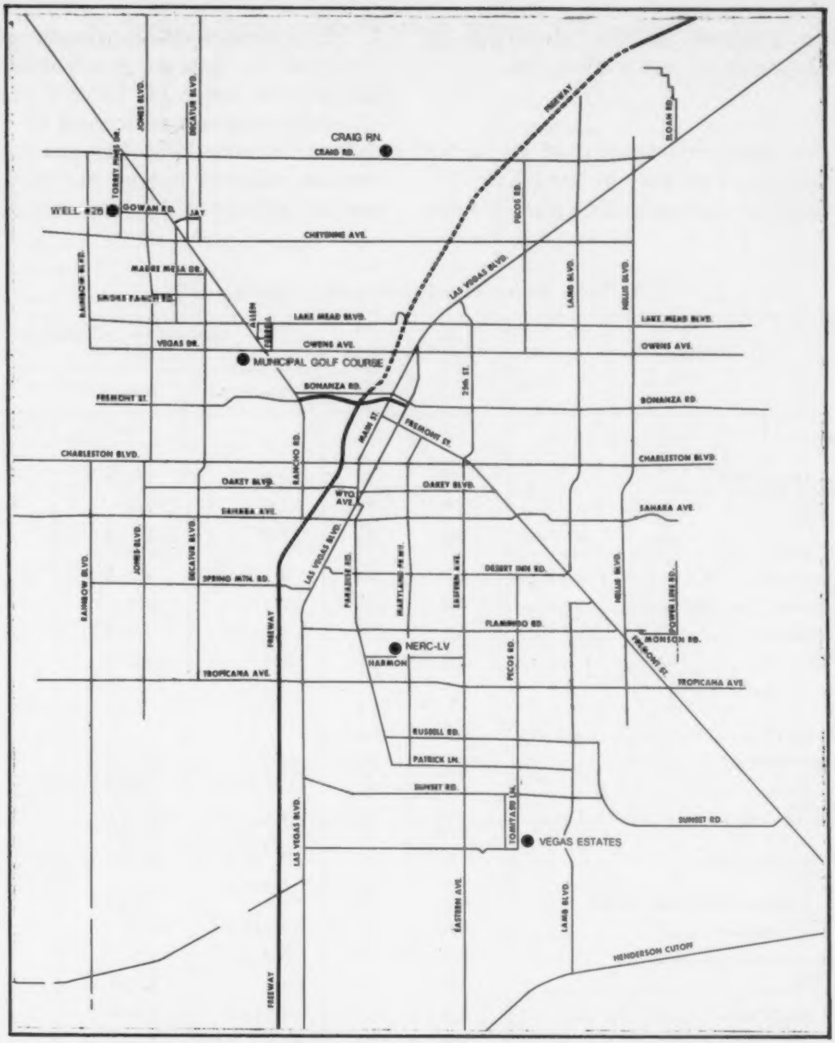

Figure 2. NERC–LV Water Surveillance Network—Las Vegas Valley

In the event of a release of radioactivity from the NTS, special sampling within the affected areas is conducted to determine radionuclide concentrations and to take protective action, if required. Additional water sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and routine analytical procedures was included with the water results reported in the July 1973 issue of *Radiation Data and Reports.*

For the purpose of identifying the source of the gross radioactivity in all network samples and comparing sample concentrations with both the AEC concentration guides and the PHS Drinking Water Standards, selected samples from each sampling location are given special analyses at least once a year beginning with calendar year 1972. For surface water samples, the special analyses includes strontium-89, strontium-90, plutonium-238, plutonium-239, uranium, and radium-226. For drinking water

samples, the analyses include strontium-89, strontium-90, uranium, and radium-226.

Results

The routine analytical results of all water samples collected in February by the NERC-LV Water Surveillance Network are listed in table 1. No gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected. Table 2 presents results of special analyses performed on water samples collected during 1972. The analytical results of samples selected during the current year for special analyses will be reported at a later date.

Table 1. Water surveillance results, February 1973

Location	Date collected (1973)	Sample type [a]	Radioactivity concentrations [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
California:					
Bishop:					
Fish and Game Office	2/1	23	<5.6	4.6±3.5	NA
Death Valley Junction:					
Lila's Cafe	2/2	23	<1.6	<3.2	480±240
Furnace Creek:					
Pond	2/2	21	<4.5	9.5±3.8	NA
Visitor Center	2/2	27	<4.1	7.2±3.6	NA
Hinkley:					
Bill Nelson Dairy	2/1	23	8.1±5.7	4.5±3.4	NA
Lone Pine:					
Forest Service Ranger Station	2/2	23	<2.0	<3.2	NA
Olancha:					
Haiwee Reservoir	2/1	21	6.3±4.3	6.2±3.5	NA
Ridgecrest:					
City Hall	2/1	23	<3.9	<3.3	NA
Nevada:					
Adaven:					
Canfield Ranch	NS				
Alamo:					
Pahranagat Lake	2/5	21	<4.4	12 ±3.7	NA
Sheri's Bar	2/5	23	<3.1	3.9±3.2	NA
Williams Dairy	2/5	23	<4.2	8.3±3.7	NA
Ash Meadows:					
Ash Meadows Lodge	2/14	23	<4.4	12 ±4.3	<250
Pond	2/14	21	7.1±6.7	8.4±4.2	NA
Austin:					
Nevada National Bank	2/5	27	33 ±7.5	12 ±3.8	NA
Blue Diamond:					
Post Office	2/9	23	5.3±4.2	<3.5	<250
Blue Jay Highway Maintenance Station	2/7	23	<3.3	4.9±3.2	NA
Cactus Springs:					
Mobil Service Station	2/14	27	2.9±2.5	<3.5	<250
Caliente:					
Agricultural Extension Station	2/7	23	6.5±4.2	<3.3	NA
Clark Station:					
Five Mile Ranch	2/6	27	<2.4	5.4±3.3	NA
Currant:					
Currant Ranch Cafe	2/7	27	5.5±4.3	3.3±3.1	NA
Diablo:					
Highway Maintenance Station	2/6	23	<2.7	5.2±3.3	NA
Reed Ranch	2/5	21	9.1±6.4	26 ±4.6	NA
Elgin:					
Water tower	2/7	23	11 ±5.7	6.9±3.6	NA
Ely:					
Chevron Service Station	2/6	24	<2.7	<3.1	NA
Comins Lake	NS				
Eureka:					
Highway Maintenance Station	2/1	24	3.6±3.3	4.7±3.4	NA
Goldfield:					
Chevron Service Station	2/5	23	<3.2	3.2±3.1	NA
Hiko:					
Crystal Springs	2/5	27	6.5±4.1	9.3±3.7	NA
Schofield Dairy	2/5	23	21 ±7.1	23 ±4.4	NA
Las Vegas:					
Craig Ranch Golf Course	2/9	23	5.6±3.6	5.3±3.4	<250
Desert Game Range	2/9	23	5.4±3.5	<3.4	<250
Lab II NERC	2/12	24	8.6±5.8	6.3±3.7	1,100±270
Lake Mead Vegas Wash	2/12	21	<4.0	5.9±3.7	1,300±270
L V Water District Well 28	2/9	23	<2.8	<3.3	<250
Municipal Golf Course	2/9	23	4.0±3.2	<3.3	<250
Tule Springs	2/9	23	3.3±2.8	<3.4	<250
Tule Springs Pond	2/9	21	<2.7	<3.4	NA
Vegas Estates	2/9	23	<4.4	13 ±4.0	<250
Lida:					
Lida Livestock Company	2/5	27	<3.2	<3.1	NA
Pond at storage tank	2/5	21	<2.8	<3.4	NA

See footnotes at end of table.

Table 1. Water surveillance results, February 1973—continued

Location	Date collected (1973)	Sample type [a]	Radioactivity concentrations [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
Nevada: continued:					
Lund:					
Gardner Grocery	2/8	23	3.8±3.2	4.3±3.2	NA
Manhattan:					
Country store	2/6	23	13 ±6.3	4.9±3.6	NA
Mesquite:					
Hughes Bros. Dairy	2/5	23	<4.7	4.4±3.4	NA
Moapa:					
Pedersen Valley View Ranch	2/5	27	8.8±5.6	11 ±3.8	NA
Mt. Charleston:					
Kyle Canyon Fire Station	2/9	27	<2.2	<3.4	<250
Nyala:					
Sharp's Ranch	2/8	23	<3.0	4.5±3.2	NA
Pahrump:					
Texaco Service Station	2/20	23	<2.5	<3.5	NA
Pioche:					
County courthouse	2/6	24	3.3±3.1	<3.3	NA
Round Mountain:					
Mobil Service Station	2/6	27	2.7±2.5	<3.4	NA
Scotty's Junction:					
Chevron Service Station	2/5	23	15 ±7.7	12 ±3.8	<250
Springdale:					
Pond	2/13	21	<4.5	6.3±3.8	NA
Sunnyside:					
Adam McGill Reservoir	NS				
Wildlife Management Headquarters	2/8	27	<2.3	<3.1	NA
Tonopah:					
Jerry's Chevron Station	2/7	23	<3.5	7.4±3.7	NA
Tonopah Test Range CP-1	2/7	23	<3.9	7.4±3.4	NA
Warm Springs:					
Fallini's Pond	2/7	21	7.0±5.5	19 ±4.1	NA
Service station and cafe	2/5	27	13 ±7.7	19 ±4.5	NA
Twin Springs Ranch	2/7	23	9.5±5.5	12 ±4.0	NA
Utah:					
Cedar City:					
M. D. Baldwin residence	2/6	24	3.5±3.3	6.0±3.4	NA
St. George:					
R. Cox Dairy	2/5	24	2.6±2.2	<3.2	NA

[a] 21—Pond, lake, reservoir, stock tank, stock pond.
22—Stream, river, creek.
23—Well.
24—Multiple supply—Mixed (A water sample consisting of mixed or multiple sources of water, such as well and spring.)
27—Spring.
[b] Two-sigma counting error provided when available.
NA, no analysis.
NS, no sample.

Table 2. Special analytical results for water samples collected during 1972

Location	Date collected (1972)	Sample type [a]	^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
			Radionuclide concentrations [b] (pCi/liter)							
California:										
Bishop:										
Fish & Game Office	4/5	23	<4	<1	0.1 ±0.08	NA	NA	0.3 ±0.05	<0.008	0.2 ±0.04
	5/9	23	<3	<0.9	.2 ± .1	NA	NA	NA	NA	NA
Owens River, 3 miles E	4/5	22	NA	NA	NA	<0.02	0.01±0.01	NA	NA	NA
Death Valley Junction:										
Lila's Cafe	4/6	23	<4	<1	.1 ± .1	NA	NA	1.6 ± .1	.059 ± .022	1.5 ± .1
Furnace Creek:										
Pond	4/6	21	NA	NA	NA	<.02	.02 ± .02	NA	NA	NA
	5/10	21	NA	NA	.1 ± .08	NA	NA	NA	NA	NA
Visitor Center	4/6	27	<4	<1	.3 ± .1	NA	NA	1.0 ± .08	.044 ± .016	1.0 ± .07
Hinkley:										
Bill Nelson Dairy	4/3	23	<4	<1	.4 ± .2	NA	NA	5.1 ± .2	.18 ± .03	4.8 ± .2
	7/3	23	NA	NA	.5 ± .2	NA	NA	NA	NA	NA
	8/1	23	NA	NA	.4 ± .2	NA	NA	NA	NA	NA
Little Lake:										
Little Lake Ranch	4/4	21	NA	NA	NA	<.02	.01 ± .01	NA	NA	NA
Lone Pine:										
Diaz Lake	4/4	21	NA	NA	NA	<.03	.02 ± .01	NA	NA	NA
	5/8	21	NA	NA	.6 ± .4	NA	NA	12 ± .5	.45 ± .09	12 ± .4
	7/5	21	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
Forest Service Ranger Station	4/5	23	<4	<1	.3 ± .1	NA	NA	.44 ± .05	.012 ± .008	.43 ± .05
	5/8	23	<3	<1	.1 ± .1	NA	NA	NA	NA	NA
Olancha:										
Haiwee Reservoir	4/4	21	NA	NA	NA	<.02	<.01	NA	NA	NA
Ridgecrest:										
City Hall	4/4	23	<5	<1	.5 ± .2	NA	NA	.4 ± .05	.012 ± .009	.4 ± .05
	5/8	23	<3	<3	.1 ± .1	NA	NA	2.6 ± .2	.09 ± .04	2.5 ± .5
Shoshone:										
Chevron Service Station	4/6	27	<4	<1	.2 ± .1	NA	NA	NA	NA	NA
Nevada:										
Alamo:										
Pahranagat Lake	2/8	21	<5	<1	.5 ± .2	<.02	<.01	6.8 ± .2	.3 ± .04	6.4 ± .2
	4/4	21	NA	NA	NA	<.03	.03 ± .02	NA	NA	NA
	7/5	21	<1	<.1	NA	NA	NA	NA	NA	NA
	8/1	21	<3	<1	NA	NA	NA	NA	NA	NA
	9/5	21	<2	1 ±1	.3 ± .1	NA	NA	NA	NA	NA
	10/2	21	<3	<1	NA	NA	NA	NA	NA	NA
	12/1	21	NA	NA	.48 ± .16	NA	NA	NA	NA	NA
Williams Dairy	2/8	23	<4	<1	.3 ± .1	<.02	<.01	1.7 ± .1	.09 ± .03	1.6 ± .1
	4/4	23	<4	<1	.1 ± .1	NA	NA	1.7 ± .1	.078 ± .026	1.6 ± .1
	5/5	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
Ash Medows:										
Ash Medows Lodge	2/9	23	<4	<1	.7 ± .2	<.02	<.01	1.6 ± .2	.06 ± .04	1.6 ± .2
	4/10	23	<5	<1	.3 ± .1	NA	NA	.8 ± .08	.028 ± .014	.8 ± .06
	5/3	23	NA	NA	.6 ± .2	NA	NA	NA	NA	NA
	8/2	23	NA	NA	.6 ± .2	NA	NA	NA	NA	NA
	11/1	23	NA	NA	.6 ± .2	NA	NA	NA	NA	NA
Pond	2/9	21	<4	<1	.3 ± .1	<.02	<.01	7.9 ± .4	.2 ± .1	7.5 ± .4
	4/10	21	NA	NA	.2 ± .1	<.02	.02 ± .02	6.4 ± .2	.21 ± .04	6.1 ± .2
	5/3	21	<3	<1	.6 ± .2	NA	NA	NA	NA	NA
	6/1	21	NA	NA	.1 ± .1	NA	NA	4.2 ± .2	.17 ± .04	3.9 ± .2
Austin:										
County courthouse	2/9	27	<4	<1	.1 ± .1	<.02	<.01	13.8 ± .6	.5 ± .1	13.0 ± .6
	4/5	27	<4	<1	<.6	NA	NA	13.0 ± .28	.37 ± .048	12.0 ± .27
	5/4	27	NA	NA	.5 ± .2	NA	NA	NA	NA	NA
	6/2	27	NA	NA	.2 ± .1	NA	NA	NA	NA	NA

See footnotes at end of table.

Table 2. Special analytical results for water samples collected during 1972—continued

Location	Date collected (1972)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)							
			^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Nevada: continued:										
Austin:										
County courthouse	7/13	27	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	9/7	27	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	10/4	27	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	12/1	27	NA	NA	.33 ± .14	NA	NA	NA	NA	NA
Beatty:										
Richfield Service Station	2/10	23	<4	<1	.2 ± .1	<.03	<.02	2.8 ± .3	.09 ± .05	2.8 ± .3
	4/6	23	<4	<1	.3 ± .1	NA	NA	2.2 ± .1	.069 ± .024	2.1 ± .1
	5/2	23	NA	NA	.1 ± .1	NA	NA	NA	NA	NA
	10/5	23	NA	NA	.4 ± .1	NA	NA	NA	NA	NA
	11/1	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
Blue Diamond:										
Post Office	4/10	23	<3	<.8	2.7 ± .5	NA	NA	NA	NA	NA
	9/6	23	NA	NA	1.2 ± .3	NA	NA	NA	NA	NA
Blue Jay Highway Maintenance Station	4/5	23	<3	<1	<.6	NA	NA	1.3 ± .09	.036 ± .017	1.2 ± .08
Cactus Springs:										
Mobile Service Station	4/7	27	<4	<1	.2 ± .1	NA	NA	.53 ± .07	.017 ± .013	.5 ± .06
Caliente:										
Agricultural Extension Station	4/4	23	<4	<1	.1 ± .1	NA	NA	1.8 ± .1	.006 ± .002	1.7 ± .1
	5/3	23	NA	NA	.1 ± .09	NA	NA	NA	NA	NA
Meadow Valley wash	4/4	22	NA	NA	NA	<.02	<.01	NA	NA	NA
Clark Station:										
Five Mile Ranch	2/10	27	<5	<1	0.6 ±0.2	<0.04	<0.02	0.3 ±0.1	0.02 ±0.01	0.2 ±0.1
	4/5	27	<3	<1	<.3	NA	NA	.2 ± .04	.015 ± .01	.2 ± .03
Coyote Summit:										
Sand Spring Well	4/5	23	NA	NA	<.6	<.02	.01 ± .01	14.0 ± .28	.48 ± .05	13.0 ± .27
	10/3	23	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
Currant:										
Currant Pond	4/6	21	NA	NA	NA	<.02	<.01	NA	NA	NA
Currant Ranch Cafe	4/6	27	<4	<1	.5 ± .2	NA	NA	2.5 ± .1	.081 ± .026	2.4 ± .1
	7/12	27	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
	10/4	27	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
Diablo:										
Highway Maintenance Station	4/5	23	<5	<1	<.6	NA	NA	.72 ± .066	.035 ± .015	.67 ± .064
Reed Ranch	2/8	21	<4	<1	.2 ± .1	<.04	<.02	3.0 ± .3	.2 ± .1	2.8 ± .3
	4/5	21	NA	NA	NA	<.03	.02 ± .02	NA	NA	NA
	6/2	21	<3	3 ±1	.2 ± .1	NA	NA	NA	NA	NA
	8/1	21	<3	<1	NA	NA	NA	NA	NA	NA
	9/6	21	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
	10/3	21	<3	1 ±1	NA	NA	NA	NA	NA	NA
Elgin:										
Water tower	4/5	23	<4	<1	.4 ± .1	NA	NA	2.4 ± .1	.098 ± .023	2.3 ± .1
	5/4	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
	7/6	23	<2	<.8	.2 ± .1	NA	NA	NA	NA	NA
Ely:										
Chevron Service Station	4/4	24	<3	<.9	.5 ± .2	NA	NA	.57 ± .06	.021 ± .011	.54 ± .06
Comins Lake	4/4	21	<4	<1	.3 ± .1	<.02	.01 ± .01	3.0 ± .1	.14 ± .03	2.8 ± .1
	5/3	21	<4	2 ±1	NA	NA	NA	NA	NA	NA
	6/1	21	3 ±3	<1	NA	NA	NA	NA	NA	NA
	7/14	21	<2	2 ±1	NA	NA	NA	4.5 ± .2	.17 ± .04	4.2 ± .2
	8/1	21	<3	<1	NA	NA	NA	NA	NA	NA
	10/2	21	<3	<1	NA	NA	NA	NA	NA	NA
Eureka:										
Chevron Service Station	4/6	24	<4	<1	.1 ± .08	NA	NA	.62 ± .07	.024 ± .014	.59 ± .07
Glendale:										
Chevron Service Station	4/4	27	<4	<.9	.6 ± .2	NA	NA	1.3 ± .1	.054 ± .029	1.2 ± .1
Muddy River	6/1	22	<2	<1	NA	NA	NA	NA	NA	NA
	7/5	22	<2	<.7	NA	NA	NA	NA	NA	NA

See footnotes at end of table.

Table 2. Special analytical results for water supplies collected during 1972—continued

Location	Date collected (1972)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)							
			^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Nevada: continued:										
Goldfield:										
Alkali Springs	2/8	21	<4	<1	.5 ± .2	<.03	<.009	.03 ± .02	.01 ± .01	.02 ± .01
	4/3	21	<4	<1	<.6	<.03	.03 ± .02	.045 ± .017	<.005	.041 ± .015
	5/3	21	<3	<1	NA	NA	NA	NA	NA	NA
	6/1	21	3 ±2	<1	NA	NA	NA	NA	NA	NA
	8/1	21	<2	<1	NA	NA	NA	NA	NA	NA
Chevron Service Station	4/3	23	<4	<1	.3 ± .1	NA	NA	.12 ± .028	<.005	.11 ± .025
Hawthorne:										
Walker Lake	2/15	21	<2	<2	.4 ± .01	NA	NA	36.2 ±1.4	1.1 ± .2	33.0 ±1.3
	6/1	21	<3	<1	NA	NA	NA	NA	NA	NA
	9/8	21	<2	2 ±1	.2 ± .1	NA	NA	NA	NA	NA
Hiko:										
Crystal Springs	2/8	27	<4	<1	.8 ± .2	<.02	<.01	1.3 ± .1	.08 ± .02	1.2 ± .1
	4/4	27	<4	<1	.8 ± .2	NA	NA	1.4 ± .1	.038 ± .017	1.4 ± .1
Schofield Dairy	2/8	23	<4	<1	0.7 ±0.2	<0.02	<0.01	9.6 ±0.3	0.36 ±0.05	9.1 ±0.3
	4/4	23	<4	<1	.2 ± .1	NA	NA	9.5 ± .4	.33 ± .08	9.0 ± .4
	5/2	23	<3	<0.9	.2 ± .1	NA	NA	NA	NA	NA
	6/2	23	<3	<1	NA	NA	NA	NA	NA	NA
	7/5	23	<3	<1	.2 ± .1	NA	NA	NA	NA	NA
	8/1	23	NA	NA	.6 ± .2	NA	NA	NA	NA	NA
	10/2	23	<2	<3	.6 ± .2	NA	NA	NA	NA	NA
	12/1	23	<2	<1	NA	NA	NA	NA	NA	NA
Indian Springs:										
Chevron Service Station	2/8	23	<4	<1	.3 ± .1	<.03	<.02	.6 ± .1	.03 ± .03	.5 ± .1
	4/6	23	<4	<1	.4 ± .2	NA	NA	.64 ± .07	.028 ± .014	.6 ± .07
	5/5	23	NA	NA	.1 ± .1	NA	NA	NA	NA	NA
Las Vegas:										
Cal-Nev Jet Fuels	4/10	23	<4	<1	.7 ± .2	NA	NA	NA	NA	NA
Craig Ranch Golf Course	4/10	23	<4	<1	1.6 ± .5	NA	NA	1.0 ± .08	.034 ± .014	1.0 ± .07
Cunningham Ranch	4/10	23	<4	<1	.3 ± .1	NA	NA	.59 ± .07	.027 ± .017	56 ± .07
Desert Game Range	2/8	23	<4	<1	.3 ± .1	<.02	<.02	1.3 ± .2	<.5	1.2 ± .2
	4/7	23	<4	<1	.2 ± .1	NA	NA	.87 ± .07	.046 ± .015	.81 ± .07
Desert Game Range Pond	4/7	21	NA	NA	NA	<.02	.02 ± .02	NA	NA	NA
Francis residence	4/10	23	<4	<1	.3 ± .1	NA	NA	1.6 ± .1	.076 ± .021	1.4 ± .1
	5/8	23	<3	<1	NA	NA	NA	NA	NA	NA
Lab II NERC	4/10	24	<5	<2	.2 ± .1	NA	NA	1.9 ± .1	.059 ± .018	1.8 ± .1
Lake Mead Vegas Wash	4/10	21	NA	NA	NA	<.02	.01 ± .01	NA	NA	NA
L V Water District Well 28	4/10	23	<4	<1	.2 ± .1	NA	NA	.29 ± .05	.013 ± .011	.28 ± .04
LDS Dairy Farms	4/11	23	<4	<1	.2 ± .1	NA	NA	1.8 ± .1	.066 ± .022	1.7 ± .1
	5/9	23	NA	NA	.1 ± .1	NA	NA	NA	NA	NA
	6/1	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
Lloyd Ranch	4/10	23	<4	<1	.2 ± .1	NA	NA	1.6 ± .1	.057 ± .017	1.5 ± .1
Municipal Golf Course	4/10	23	<4	<1	.3 ± .1	NA	NA	.65 ± .07	.023 ± .013	.62 ± .07
	7/10	23	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
Tule Springs	4/7	23	<4	<1	.4 ± .2	NA	NA	.67 ± .07	.081 ± .015	.62 ± .07
	9/5	23	NA	NA	<.1	NA	NA	NA	NA	NA
Vegas Estates	4/10	23	<4	<.9	.2 ± .1	NA	NA	.47 ± .06	.02 ± .013	.44 ± .06
Lathrop Wells:										
Texaco Service Station	4/6	23	<4	<1	.1 ± .1	NA	NA	.36 ± .06	.011 ± .009	.34 ± .06
	6/1	23	<2	<1	NA	NA	NA	NA	NA	NA

See footnotes at end of table.

Table 2. Special analytical results for water samples collected during 1972—continued

Location	Date collected (1972)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter) ^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Nevada: continued										
Lida:										
Lida Livestock Company	4/3	27	<4	<1	.1 ± .08	NA	NA	.64 ± .07	.017 ± .013	.61 ± .07
Pond at storage tank	4/3	21	NA	NA	NA	<.02	.01 ± .01	NA	NA	NA
Lida Junction:										
Cottontail Ranch	4/3	23	<4	<1	<.4	NA	NA	1.3 ± .09	.058 ± .019	1.2 ± .09
	5/5	23	NA	NA	.1 ± .09	NA	NA	NA	NA	NA
	6/1	23	<2	<1	NA	NA	NA	NA	NA	NA
	9/5	23	NA	NA	.4 ± .2	NA	NA	NA	NA	NA
Lund:										
Gardner Grocery	4/5	23	<4	<1	.2 ± .1	NA	NA	1.1 ± .1	.032 ± .015	1.1 ± .1
Manhattan:										
Country store	4/5	23	<3	<1	<0.6	NA	NA	4.0 ±0.15	0.26 ±0.04	3.8 ±0.15
	5/4	23	NA	NA	.4 ± .1	NA	NA	NA	NA	NA
	6/2	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
	7/11	23	NA	NA	.7 ± .2	NA	NA	NA	NA	NA
	8/2	23	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	9/6	23	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	10/4	23	NA	NA	.4 ± 2	NA	NA	NA	NA	NA
	11/2	23	NA	NA	.2 ± .1	NA	NA	NA	NA	NA
	12/1	23	NA	NA	.2 ± .12	NA	NA	NA	NA	NA
Seyler Reservoir	4/5	21	<4	<1	NA	<.02	.02 ± .01	NA	NA	NA
	9/6	21	<2	<1	.3 ± .1	NA	NA	NA	NA	NA
Mercury:										
Groom Lake	4/4	23	<3	<1	<.6	NA	NA	NA	NA	NA
Moapa:										
Pedersen Valley View Ranch	4/4	27	<4	<1	1.0 ± .2	NA	NA	1.3 ± .1	.053 ± .023	1.2 ± .1
	6/2	27	<3	<.9	NA	NA	NA	NA	NA	NA
Mt. Charleston:										
Kyle Canyon Pond	4/7	21	NA	NA	NA	<.03	<.01	NA	NA	NA
Nyala:										
Sharp's Ranch	4/5	23	<5	<2	<.6	NA	NA	.72 ± .068	.02 ± .012	.68 ± .068
Pahrump:										
Texaco Service Station	4/10	23	<5	<1	.2 ± .1	NA	NA	.7 ± .078	.035 ± .017	NA
Pioche:										
County courthouse	4/5	24	<4	<1	.1 ± .09	NA	NA	.7 ± .077	.026 ± .015	.66 ± .075
	7/6	24	<2	<.8	NA	NA	NA	NA	NA	NA
	8/2	24	NA	NA	.5 ± .2	NA	NA	NA	NA	NA
Round Mountain:										
Mobil Service Station	4/5	27	<4	<1	.2 ± .1	NA	NA	.74 ±.08	.029 ± .017	.7 ± .08
Scotty's Jct:										
Chevron Service Station	4/3	23	<4	<1	.3 ± .1	NA	NA	1.9 ± .1	.081 ± .025	1.8 ± .1
Springdale:										
Peacock Ranch	4/12	27	<3	<.9	.2 ± .1	NA	NA	1.0 ± .1	.03 ± .016	.9 ± .1
	6/2	27	<2	<1	NA	NA	NA	NA	NA	NA
Pond	4/12	21	NA	NA	NA	<.02	<.01	NA	NA	NA
Sunnyside:										
Wildlife Management Headquarters	4/5	27	<4	<1	.1 ± .08	NA	NA	.48 ± .06	.02 ± .012	.45 ± .06
Tonopah:										
Tonopah Test Range CP-1	4/4	23	<4	<1	.1 ± .1	NA	NA	1.7 ± .1	.056 ± .022	1.6 ± .1
Warm Springs:										
Feilini's Pond	4/5	21	<4	<1	.6 ± .6	<.03	.09 ± .03	5.0 ± .2	.14 ± .03	4.8 ± .2
	5/3	21	<3	<1	NA	NA	NA	NA	NA	NA
	6/1	21	3 ±2	<1	NA	NA	NA	NA	NA	NA
	7/6	21	2 ±2	<.8	1.2 ± .2	NA	NA	NA	NA	NA
	8/2	21	<4	2 ±2	1.3 ± .2	NA	NA	2.6 ± .32	.19 ± .09	2.4 ± .3
	10/4	21	NA	NA	1.3 ± .2	NA	NA	NA	NA	NA
	11/4	21	<2	4.3 ±1.2	NA	NA	NA	NA	NA	NA
	12/6	21	<2	<1.1	NA	NA	NA	NA	NA	NA
Hot Creek Ranch	4/5	27	<3	<1	<.4	NA	NA	NA	NA	NA
	10/4	27	<2	<1	NA	NA	NA	NA	NA	NA

See footnotes at end of table.

Location	Date collected (1972)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)							
			^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Nevada: continued										
Warm Springs:										
Service station and cafe	4/5	27	<3	<1	6.9 ±2.4	NA	NA	.28 ± .042	.014 ± .009	.26 ± .041
	6/1	27	<2	<1	9.7 ± .7	NA	NA	NA	NA	NA
	7/5	27	NA	NA	8.0 ± .6	NA	NA	NA	NA	NA
	8/2	27	NA	NA	10 ±0.6	NA	NA	NA	NA	NA
	10/3	27	<2	<1	11 ± .7	NA	NA	NA	NA	NA
	11/13	27	<2	<2	11 ± .8	NA	NA	NA	NA	NA
Twin Springs Ranch	4/5	23	<3	<1	<.2	NA	NA	1.4 ± .086	.055 ± .017	1.3 ± .083
	7/6	23	NA	NA	.4 ± .2	NA	NA	NA	NA	NA
	9/7	23	NA	NA	<.1	NA	NA	NA	NA	NA
Utah:										
Cedar City:										
M. D. Baldwin Residence	4/5	24	<4	<1	.2 ± .1	NA	NA	.4 ± .05	.017 ± .01	.4 ± .05
	8/1	24	NA	NA	.3 ± .1	NA	NA	NA	NA	NA
	9/6	24	NA	NA	<.1	NA	NA	NA	NA	NA
Garrison:										
Rowley Grocery	4/4	23	<4	<1	.2 ± .1	NA	NA	1.3 ± .1	.054 ± .02	1.3 ± .1
Newcastle:										
Newcastle Dairy	4/6	24	<4	<1	.4 ± .1	NA	NA	1.2 ± .08	.05 ± .02	1.1 ± .08
Municipal Reservoir	4/5	21	NA	NA	NA	<.02	.02 ± .02	NA	NA	NA
St. George:										
R. Cox Dairy	4/5	24	<3	<.8	.2 ± .1	NA	NA	.98 ± .09	.036 ± .016	.92 ± .09
	7/5	24	NA	NA	.4 ± .2	NA	NA	NA	NA	NA

[a] 21—Pond, lake, reservoir, stock tank, stock pond.
22—Stream, river, creek.
23—Well.
24—Multiple supply—mixed (A water sample consisting of mixed or multiple sources of water, such as well and spring.)
27—Spring.

[b] Two-sigma counting error provided when available.
NA, no analysis.

Radioactivity in New York State Surface Water July–December 1971

Bureau of Radiological Pollution Control
N.Y.S. Department of Environmental Conservation

In 1955 the New York State Department of Health began a program to determine the amount of radioactivity in water used for public consumption. Radioactivity in water may arise from any one or a combination of the following sources: the natural mineral content of water (background), atmospheric fallout, or nuclear industry operations.

Analytical procedures

Analysis of samples was performed by the Radiological Sciences Laboratory of the New York State Department of Health. The procedures described below were used to perform the indicated analyses.

A gross beta determination is made on a measured quantity of water, usually 250 ml. The sample residue is analyzed for its gross beta component in an end window, gas flow proportional counter.

Strontium and alkaline earths are precipitated as carbonates from a 500 ml sample. Iron and rare earths are removed by hydroxide scavenging, while barium is precipitated as a chromate. Strontium is finally precipitated as a sulfate from a pH controlled EDTA solution. Calcium and yttrium remain in solution as EDTA complexes (*1–2*). Strontium-90 is determined by yttrium-90 counting of the final precipitate at less than 6 hours after precipitation and again at greater than 50 hours using a flow proportional counter. Strontium-89 is estimated by taking the difference between the total radiostrontium and the strontium-90 radioactivity. Chemical recovery is between 70 and 75 percent and results in a minimum detectable radioactivity of 3 pCi/liter $\pm$ 100 percent at the 95 percent confidence level.

Tritium in water is determined by liquid scintillation counting. The sample is vacuum distilled and an aliquot mixed with a scintillation cocktail (either 15 ml of Aquasol and 6 ml of distillate or 17 ml of a dioxane-base cocktail and 3 ml of distillate). Samples are counted for 50 minutes in either a Packard Tri-Carb model 3315 or Beckman LS200B liquid scintillation spectrometer. Minimum sensitivities are 1,000 pCi/liter for the Tri-Carb and 500 pCi/liter for the Beckman.

Discussion and results

The concentrations of radionuclides in most water samples throughout the State were low with exception of the water immediately downstream of the Nuclear Fuel Services fuel reprocessing plant (NFS) discharge (figure 1).

Three daily samples from Cattaraugus Creek at Springville Dam, Site 042 exceeded 600 pCi/liter of gross beta radioactivity which is considered to be the allowable AEC limit for a single sample without making a specific isotopic analysis.

Specific isotopic analyses were made on each of the three samples collected on October 7, 8, and November 4, 1971 and the concentration of the major isotopes present were determined (table 1).

The number of samples, quarterly average, maximum and minimum gross beta-particle concentrations in New York surface water for July–December 1971 are given in table 2.

Tritium concentration values for July–December 1971 are given in table 3. Tritium, the radioactive isotope of hydrogen, a very low beta-particle emitter, is released to the water courses during the reprocessing of nuclear fuel. The tritium concentrations in Cattaraugus and Buttermilk Creeks reflected contributions to the streams from the Nuclear Fuel Services reprocessing plant.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
July–December 1970 and January–June 1971	May 1972

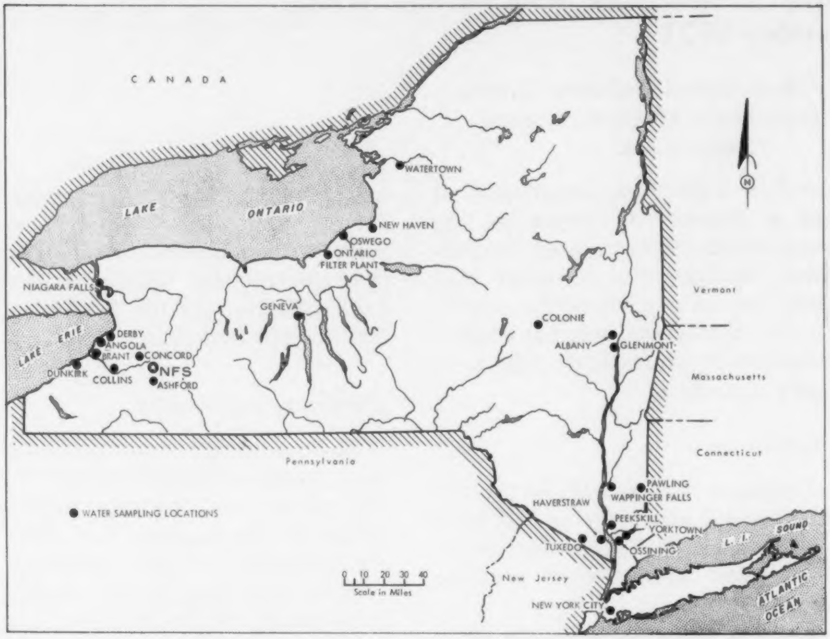

Figure 1. New York water sampling locations

Table 1. Radioactivity in Cattaraugus Creek at Springville Dam, Site 042, 1971

Radionuclide	October 6–7, 1971		October 7–8, 1971		November 3–4, 1971		
	Concentration (pCi/liter)	Percent of AEC standards	Concentration (pCi/liter)	Percent of AEC standards	Concentration (pCi/liter)	Percent of AEC standards	AEC standard (pCi/liter)
Gross beta	1,023		795		1,175		
Strontium-90	68	22.6	117	39.0	100	33.32	300
Ruthenium-106	799	7.98	545	5.46	862	6.62	10,000
Cesium-137	ND	.0	18	.10	74	.38	20,000
Cobalt-60	ND	.0	ND	.0	9	.0	50,000
Cesium-134	ND	.0	ND	.0	29	.32	9,000
Antimony-125	55	.0	39	.0	120	.02	1,000,000
Tritium	100,940	3.36	51,670	1.72	41,410	1.38	3,000,000

ND, nondetectable.

REFERENCES

(*1*) PORTER, C., D. CAHILL, R. SCHNEIDER, P. ROBBINS, W. PERRY and B. KAHN. Anal Chem 33:1356 (1961).

(*2*) WELFORD, G. and D. SUTTON. A paper presented at the American Chemical Society meeting in New York City, September 1960.

Table 2. Gross beta radioactivity in New York raw surface water,[a] July-December 1971

Location	Gross beta radioactivity (pCi/liter): July–September 1971, Number of samples	Average	Maximum	Minimum	October–December 1971, Number of samples	Average	Maximum	Minimum
Albany	3	1	3	ND	3	2	2	2
Angola (Angola Water Treatment Plant)	13	6	20	4	12	6	8	4
Ashford (Buttermilk Creek at Fox Valley Road)	3	4	5	3	3	4	8	ND
(Buttermilk Creek at Thomas Corners)[b]	13	5,167	8,665	2,226	13	3,299	12,294	179
(Cattaraugus Creek at Bigelow Bridge)	3	4	6	3	3	3	4	ND
Brant (Cattaraugus Creek at Irving)	13	115	196	72	14	106	288	41
Collins (Cattaraugus Creek at Gowanda)	4	86	138	48	NS			
Colonie (Filtration Plant)	13	4	5	3	13	3	5	3
Concord (Cattaraugus Creek at Springville Dam):								
Weekly composite sample	13	269	515	118	13	304	541	122
Daily continuous sample	64	262	573	91	59	299	1,175	35
Derby (Sturgeon Point)	13	6	17	4	11	5	7	3
Dunkirk (Dunkirk Filtration Plant)	14	4	15	2	11	3	4	2
Geneva (Seneca Lake)	3	6	7	5	3	4	5	3
Glenmont (Hudson River)	12	4	5	2	11	3	5	2
Haverstraw (Iona Filtration Gallery)	2	18	26	11	1	3		
New Haven (Demster Beach Road)	1	3			3	4	5	3
New York City	5	2	3	ND	3	3	4	2
Niagara Falls (West Branch Niagara River)	2	7	10	3	2	5	5	4
Ontario Filter Plant	13	4	6	3	12	4	5	4
Ossining (Hudson River at Sing Sing)	13	37	65	ND	11	18	63	ND
(Indian Brook Reservoir—raw)	3	7	11	ND	4	5	6	4
(Indian Brook Reservoir—treated)	3	2	4	ND	4	4	7	ND
Oswego	6	4	5	3	6	4	5	3
Pawling (Pond at United Nuclear)	4	4	7	3	3	2	2	2
Peekskill (Camp Field Filter Plant—raw)	3	14	38	ND	4	5	11	3
(Camp Field Filter Plant—treated)	3	2	4	ND	4	2	5	ND
(Hudson River at Standard Brands)	13	26	183	ND	11	15	35	ND
Rhinecliff (Hudson River)	7	4	6	3	8	3	4	2
Tuxedo (Indian Kill)	2	6	12	ND	NS			
(Indian Kill, 150 feet below reservoir)	3	5	12	ND	4	4	4	4
Wappinger (Hudson River)	6	3	4	ND	8	4	8	2
Watertown (Black River)	3	2	4	ND	3	3	5	2
Yorktown (Croton Reservoir)	3	12	28	4	4	4	5	2
(Croton Reservoir—deep well)	3	3	4	3	4	4	6	2

[a] Excluding tritium all strontium-90 concentrations were below detectable levels except during July-September at Peekskill (Hudson River at Standard Brands), 13 samples collected; maximum—3 pCi/liter, and ND for minimum and average; Ossining (Hudson River at Sing Sing), 12 samples collected; maximum—4 pCi/liter and ND for the minimum and average. October-December at Ossining (Hudson River at Sing Sing), 11 samples with a maximum of 4 pCi/liter and ND for minimum and average; Peekskill (Hudson River at Standard Brands), 11 samples with a maximum of 6 pCi/liter and ND for minimum and average.

[b] This station is on the Nuclear Fuels Services reprocessing plant site. ND, nondetectable. NS, no sample.

Table 3. Tritium concentration of New York surface waters, July-December 1971

Location	Tritium concentration (nCi/liter): July–September 1971, Number of samples	Average	Maximum	Minimum	October–December 1971, Number of samples	Average	Maximum	Minimum
Albany	3	ND	ND	ND	3	ND	ND	ND
Angola (Water Treatment Plant)	5	ND	1.0	ND	4	ND	ND	ND
Ashford (Buttermilk Creek at Fox Valley Road)	3	ND	2.7	ND	3	ND	ND	ND
(Buttermilk Creek at Thomas Corners Road)[a]	13	1,060	1,480	450	13	329	774	7.5
(Cattaraugus Creek at Bigelow Bridge)	3	ND	ND	ND	3	ND	ND	ND
Brant (Cattaraugus Creek at Irving)	13	47.4	95.3	23.0	14	19.6	67.0	ND
Collins (Cattaraugus Creek at Gowanda)	13	42.0	69.1	27.6	NS			
Colonie (Filtration Plant)	7	ND	ND	ND	4	ND	ND	ND
Concord (Springville Power Dam on Cattaraugus Creek):								
Weekly composite sample	13	65.4	161	36.4	13	38.8	98.0	5.0
Daily continuous sample	64	64.6	181	20.7	59	41.2	184	ND
Derby (Sturgeon Plant)	5	ND	ND	ND	NS			
Dunkirk (Filtration Plant)	7	ND	ND	ND	2	ND	ND	ND
Geneva (Seneca Lake)	3	ND	ND	ND	3	ND	1.2	ND
New Haven (Demster Beach)	1	ND			3	ND	ND	ND
Ontario (Water Filtration Plant)	13	ND	ND	ND	12	ND	ND	ND
Oswego (City Hall Tap)	6	ND	1.0	ND	2	ND	ND	ND
Pawling (Pond at United Nuclear)	2	ND	ND	ND	NS			
Rhinecliff (Hudson River)	7	ND	ND	ND	8	ND	ND	ND
Tuxedo (Indian Kill, 150 feet below reservoir)	8	ND	ND	ND	3	ND	ND	ND
Wappinger (Hudson River)	6	ND	ND	ND	8	ND	ND	ND

[a] This station is on the Nuclear Fuels Services reprocessing plant site. ND, nondetectable. NS, no sample.

[b] Daily continuous sample.

Radioactivity in Washington Surface Water [1] July 1970–June 1971

Washington State Department of Social and Health Services

Radioanalysis of surface water samples collected through the State is one of the major functions of the Washington State Department of Social and Health Services radiation surveillance program. Some surface water samples are collected monthly or quarterly by the Washington State Department of Ecology. Selected stations on the Columbia River are sampled weekly or monthly by local health departments. Cedar River, a major water supply for the greater Seattle area, is sampled monthly by the City of Seattle Water Department. Figure 1 shows the surface water sampling locations and code numbers.

All water is collected in 2-liter polyethylene bottles by grab sampling and is mailed to the State radiation laboratory in Seattle for analysis. Some special analyses are performed by the National Environmental Research Center—Las Vegas (NERC-LV).

Analytical procedures

Surface water samples are analyzed for gamma-ray emitters and then separated into suspended and soluble fractions for gross beta counting. All Columbia River samples are also

[1] Summarized from "Environmental Radiation Surveillance in Washington State," Tenth Annual Report, July 1970–June 1971.

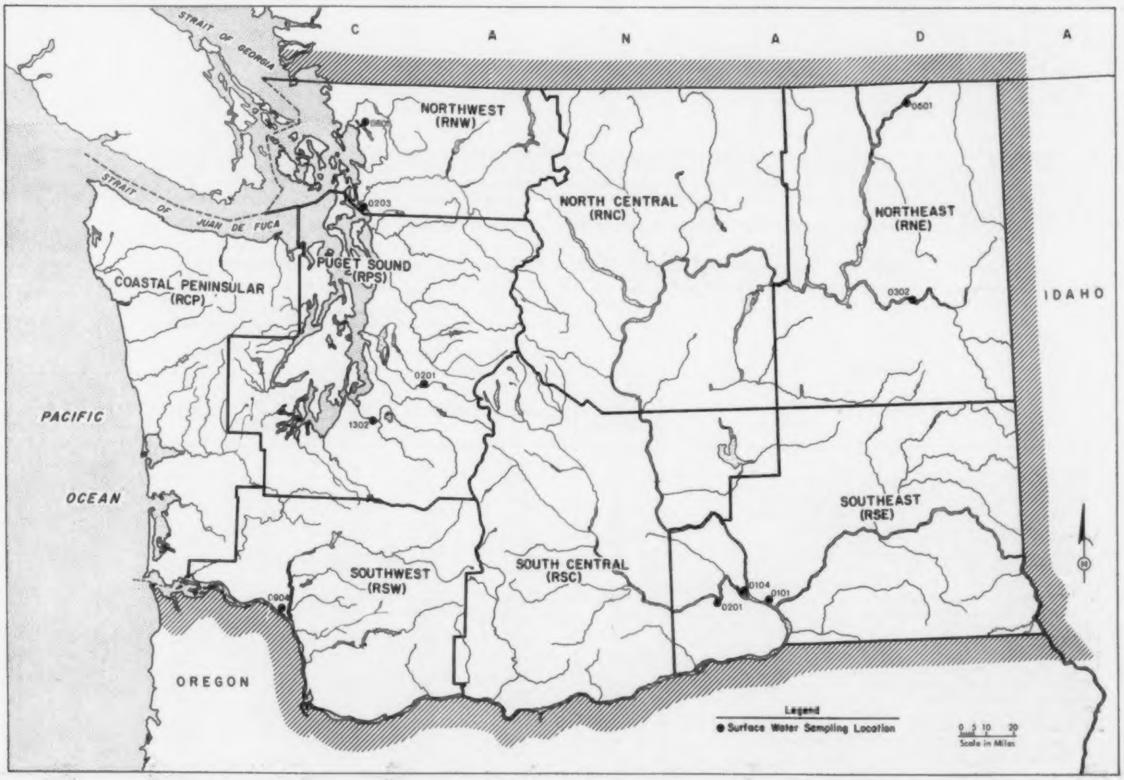

Figure 1. Washington surface water sampling locations with code numbers

analyzed for phosphorus-32, a pure beta-particle emitter which is not detectable in the gamma-ray scan.

For the gamma radioanalysis, the samples are placed in stainless steel Marinelli beakers as soon after receipt as possible. Distilled water is added when necessary to obtain 2,000 ml geometry. After analysis by gamma spectroscopy, surface water (except Columbia River) is filtered through Whatman No. 42 filter paper. The filter paper containing the suspended solids is ashed in a muffle furnace at 600° C., plancheted, weighed, and submitted for gross beta counting. The filtrate, evaporated to near dryness, is quantatively transferred to a tared planchet, dried, weighed, and submitted for gross beta counting.

The gamma analysis of the Columbia River samples is started approximately 14 days after collection. After the gamma spectroscopic analysis, Columbia River samples are divided into two aliquots. One aliquot is prepared for standard gross beta counting as described above, while the second aliquot is prepared for phosphorus-32 counting. The technique used for phosphorus-32 separation is a modification of published methods (*1–4*). After a waiting period of 15 days following collection to allow arsenic-76 and other short-lived interfering radionuclides to decay, the phosphorus is separated from the interfering radionuclides by precipitation as ammonium phosphomolybdate from an acid medium. The precipitate is washed with ammonium nitrate, dissolved with 3N ammonium hydroxide, transferred into a tared planchet, dried, ashed at 450° C., weighed, and counted for beta radioactivity.

Analyses results of Columbia River samples are reported separately because of the unique isotopes present (table 1). The data reflect the more detailed laboratory analysis that Columbia River samples receive in order to document the

Table 1. Monthly average radioactivity in Columbia River water, July 1970–June 1971

Location and type of analysis	Concentration (pCi/liter)											
	1970						1971					
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Northport (code No. RNE 0601)												
Beta-particle:												
Suspended [a]	NS	<1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dissolved [a]	NS	2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total	NS	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus-32 [b]	NS	<1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gamma-ray [b]												
Chromium-51	NS	<100	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc-65	NS	<20	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Scandium-46	NS	<10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Richland (code No. RSE 0104)												
Beta-particle:												
Suspended [a]	129	46	67	178	195	3	124	12	10	2	8	6
Dissolved [a]	109	50	159	112	105	15	88	11	5	3	4	5
Total	238	96	226	290	300	18	212	23	15	5	12	11
Phosphorus-32 [b]	36	12	38	44	36	6	32	2	<1	<1	<1	<1
Gamma-ray [b]												
Chromium-51	397	380	890	785	643	200	493	<50	<50	<50	<50	<50
Zinc-65	<40	53	59	81	64	54	52	12	12	<10	<10	8
Scandium-46	117	89	131	265	142	<20	162	39	15	<5	6	8
Pasco (code No. RSE 0101)												
Beta-particle:												
Suspended [a]	13	14	12	32	5	4	6	19	1	1	2	1
Dissolved [a]	26	24	26	38	16	10	8	6	2	2	4	3
Total	39	38	38	70	21	14	14	25	3	3	6	4
Phosphorus-32 [b]	19	19	17	40	10	5	3	2	<1	<1	<1	<1
Gamma-ray [b]												
Chromium-51	304	348	350	570	<100	<100	<100	<50	<100	<100	<100	<100
Zinc-65	<20	34	43	44	<20	<20	<20	19	<20	<20	<20	<20
Scandium-46	19	23	21	52	22	24	22	87	<10	<10	<10	<10
Longview (code No. RSW 0904)												
Beta-particle:												
Suspended [a]	2	<1	<1	1	<1	3	NS	3	1	1	NS	NS
Dissolved [a]	4	5	3	5	5	6	NS	5	2	3	NS	NS
Total	6	5	3	6	5	9	NS	8	3	4	NS	NS
Phosphorus-32 [b]	1	<1	<1	2	1	3	NS	3	<1	<1	NS	NS
Gamma-ray [b]												
Chromium-51	<100	<100	<100	115	<100	<100	NS	<100	<100	<100	NS	NS
Zinc-65	<20	<20	<20	<20	<20	<20	NS	<20	<20	<20	NS	NS
Scandium-46	<10	<10	<10	<10	<10	<10	NS	<10	<10	<10	NS	NS

[a] Activity at time of counting. Strontium-90, yttrium-90 calibration standard.
[b] Results extraporated to date of sample collection.
NS, no sample.

significant isotopes present. There are some short half-life isotopes such as sodium-24 (15 hour), arsenic-76 (27 hour), and neptunium-239 (56 hour) which are allowed to decay before analysis. This is due partly to the unavoidable delay occurring during transport of the sample to the laboratory and also because the decay of isotopes with half-life less than 2.5 days allows for a more accurate gamma analysis of the isotopes of chromium-51, zinc-65, and scandium-46.

Monthly averages of monitoring data from the Columbia River at Richland have been plotted to show the fluctuating concentrations encountered for the period 1964 through June 1971. Figures 2, 3, 4, and 5 show phosphorus-32, scandium-46, chromium-51, and zinc-65 concentrations, respectively. Plots of data for Pasco and Vancouver in previous annual reports have been replaced by the plots of data from Richland because of its closer proximity to the Hanford project.

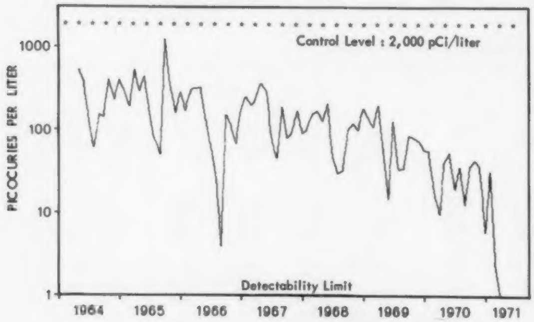

Figure 2. Phosphorus-32 monthly averages in Columbia river water, Richland, April 1964–June 1961

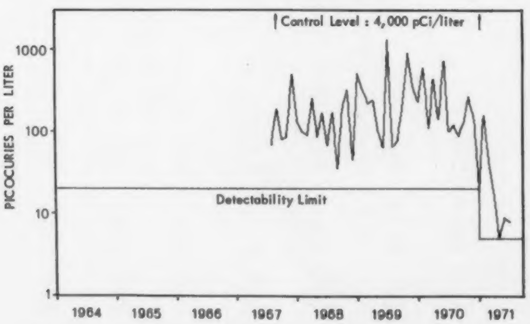

Figure 3. Scandium-46 monthly averages in Columbia river water, Richland, July 1967–1971

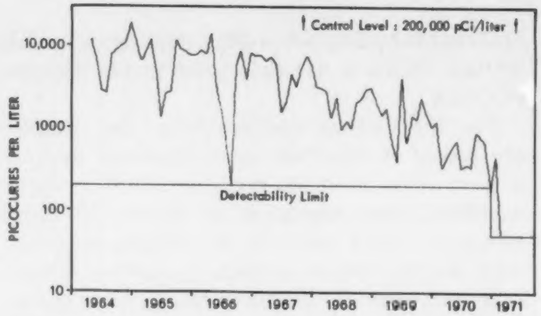

Figure 4. Chromium-51 monthly averages in Columbia river water, Richland, April 1964–June 1971

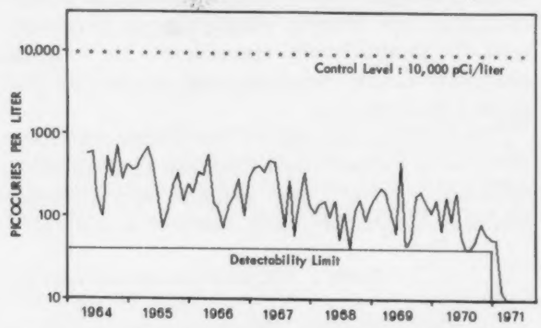

Figure 5. Zinc-65 monthly averages in Columbia river water, Richland, April 1964–June 1971

Concentrations of radioactivity in the Columbia River dropped below detectable limits following the shutdown on January 29, 1971, of the KE and the N reactors at Hanford. The KE reactor was the last of eight original plutonium producing reactors. These eight reactors used single pass cooling systems for the reactor core and were the major sources of radioactivity entering the Columbia River. The N reactor was designed for both plutonium and electrical power production. It uses a double loop cooling system so that river water used for cooling does not enter the reactor core. Its contribution of radioactivity to the river in comparison with the reactors using single pass cooling is negligible. Because of its critical value to the Northwest's energy supply, subsequent negotiations resulted in a reactivation of the N reactor.

Surface waters, other than the Columbia River, are sampled to monitor the combined effect of background and of atmospheric fallout

Table 2. Beta radioactivity[a] in Washington surface water (except for Columbia River) July 1970–June 1971

Sampling location	Concentrations (pCi/liter)											
	1970						1971					
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Cedar River (PS0201)												
Landberg:												
Suspended	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dissolved	<1	<1	<1	<1	1	<1	<1	<1	1	1	2	1
Lake Whatcom (NW0601)												
Bellingham:												
Suspended	<1	<1	<1	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dissolved	2	2	2	NS	NS	NS	NS	NS	NS	NS	NS	NS
Puyallup River (PS1302)												
Puyallup:												
Suspended	4	2	11	NS	NS	NS	2	<1	<1	<1	<1	NS
Dissolved	2	2	3	NS	NS	NS	2	1	2	2	1	NS
Skagit River (NW0203)												
Conway:												
Suspended	NS	NS	NS	NS	NS	NS	<1	2	<1	<1	NS	<1
Dissolved	NS	NS	NS	NS	NS	NS	1	1	2	1	NS	2
Spokane River (NE0302)												
Long Lake:												
Suspended	NS	<1	<1	NS	NS	NS	2	<1	NS	1	<1	<1
Dissolved	NS	2	2	NS	NS	NS	2	2	NS	2	2	2
Yakima River (SE0201)												
Kiona:												
Suspended	NS	NS	NS	NS	NS	NS	1	<1	<1	<1	2	1
Dissolved	NS	NS	NS	NS	NS	NS	3	2	3	2	2	3

[a] Activity at time of counting. Strontium-yttrium-90 calibration standard. No detectable gamma activity present.
NS, no sample.

(table 2). Figure 6 shows annual average and maximum gross beta activity in surface water samples for the period 1963 through 1971. The 1967 peak of 26 pCi/liter on the plotted maximum values occurred in a Snake River sample resulting from fallout from the Chinese nuclear detonation of December 27, 1966. Other peak values on the plot were caused by high turbidity samples.

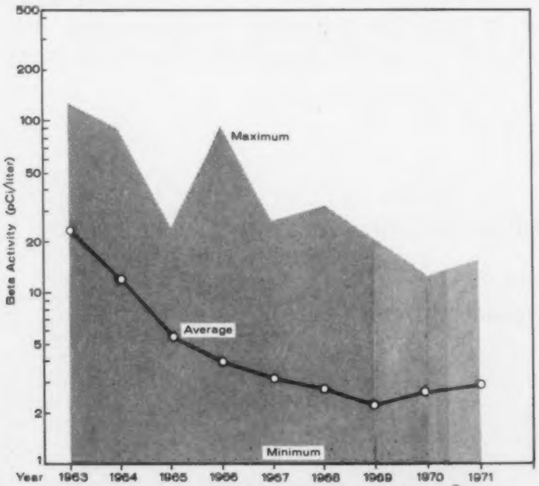

Figure 6. Average, maximum, and minimum beta radioactivity in surface waters (excluding the Columbia river), 1963–1971

Table 3 presents the individual sample results from the tritium analyses performed by the National Environmental Research Center—Las Vegas (NERC-LV).

Previous coverage in *Radiation Data and Reports:*

Period	Issue
July 1969–June 1970	March 1972

Table 3. Tritium[a] in Columbia River water July 1970–June 1971

Sampling location	Collection date	Concentration (pCi/liter)
Northport	10/ 5/1970	800
	10/18/1970	750
	2/10/1971	830
	3/ 5/1971	940
Pasco	10/ 2/1971	1,000
	1/15/1971	920
	4/ 6/1971	940
Longview	4/20/1971	720

[a] Analyses performed by National Environmental Research Center—Las Vegas (NERC-LV).

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(1) KOLTHOFF and SANDELL. Textbook of quantitative inorganic analysis, Revised Edition. The MacMillan Company, New York, N.Y. (1949), pp. 390–397; 713–717.

(2) HILLENBRAND, W. F. and G. LUNDELL. Applied inorganic analysis. John Wiley and Sons, Inc., New York, N.Y. (1953), pp. 694–710.

(3) FURMAN, N. H. Scotts' standard method of analysis, 5th Edition, Vol. 1. Van Nostrand Company, Inc., New York, N.Y. (1944), pp. 694–697.

(4) HANFORD ATOMICS PRODUCTS OPERATIONS. Radiological chemical analysis: River analysis manual—phosphorus-32 determination. Hanford Facility, Richland, Wash.

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports*.

Network	Period	Issue
Plutonium in airborne particulates	October–December 1972	June 1973
Surface air sampling program, 80th Meridian Network, *HASL*	1970	May 1973
Mexican Air Monitoring Program	September–December 1972	June 1973

1. Radiation Alert Network
April 1973

Quality Assurance and Environmental Monitoring Laboratory, National Environmental Research Center—Research Triangle Park Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 68 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Quality Assurance and Environmental Monitoring Laboratory, NERC—RTP, EPA, Research Triangle Park, N.C. 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during April 1973.

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, April 1973

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Precipitation				
			Maximum	Minimum	Average [a]	Number of samples	Total depth (mm)	Field estimation of deposition		
								Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	19	1	0	0	5	224	5	224	23
Alaska:	Anchorage	2	0	0	0	0				
	Attu Island	30	0	0	0	0				
	Fairbanks	0				0				
	Juneau	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	16	6	0	2	0				
Ark:	Little Rock	0				0				
Calif:	Berkeley	20	0	0	0	0				
	Los Angeles	21	1	0	1	0				
C.Z:	Ancon	13	0	0	0	0				
Colo:	Denver	20	3	0	1	3	43	(b)		
Conn:	Hartford	18	0	0	0	11	136	11	136	0
Del:	Dover	19	1	0	0	0				
D.C:	Washington	24	0	0	0	0				
Fla:	Jacksonville	20	0	0	0	5	161	5	161	7
	Miami	5	0	0	0	0				
Ga:	Atlanta	0				0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	20	0	0	0	0	12	(b)		
Idaho:	Boise	19	2	0	1	4	44	4	44	1
Ill:	Springfield	12	1	0	0	0				
Ind:	Indianapolis	17	1	9	0	0				
Iowa:	Iowa City	21	1	0	1	4	110	4	110	11
Kans:	Topeka	21	3	0	1	5	84	5	84	1
Ky:	Frankfort	12	1	0	0	0				
La:	New Orleans	20	1	0	0	6	329	(b)		
Maine:	Augusta	19	1	0	0	6	85	6	85	0
Md:	Baltimore	20	1	0	0	9	81	9	81	0
Mass:	Lawrence	20	1	0	0	7	168	7	168	0
	Winchester	20	1	0	0	7	145	7	145	0
Mich:	Lansing	19	1	0	0	8	43	8	43	3
Minn:	Minneapolis	18	2	0	1	4	43	4	43	11
Miss:	Jackson	6	0	0	0	2	48	2	48	0
Mo:	Jefferson City	19	1	0	0	4	73	4	73	5
Mont:	Helena	12	1	0	0	2	7	2	7	0
Nebr:	Lincoln	21	9	0	2	4	26	4	26	1
Nev:	Las Vegas	21	3	0	1	0				
N.H:	Concord	0				0				
N.J:	Trenton	15	1	0	0	9	186	9	186	6
N. Mex:	Santa Fe	14	2	0	1	0				
N.Y:	Albany	20	1	0	1	0				
	Buffalo	20	1	0	0	0				
	New York City	0				0				
N.C:	Gastonia	19	7	0	1	1	2			
N. Dak:	Bismarck	20	6	0	2	4	19	3	8	1
Ohio:	Cincinnati	0				0				
	Columbus	5	0	0	0	0				
	Painesville	21	1	0	0	10	106	10	106	26
Okla:	Oklahoma City	0				0				
Oreg:	Portland	21	1	0	0	5	42	5	42	1
Pa:	Harrisburg	17	1	0	0	0				
P.R:	San Juan	0				0				
R.I:	Providence	21	1	0	0	0				
S.C:	Columbia	7	1	0	0	2	147	2	147	0
S. Dak:	Pierre	4	3	2	2	0				
Tenn:	Nashville	20	1	0	0	10	162	10	162	0
Tex:	Austin	21	3	0	2	4	58	(b)		
	El Paso	20	3	1	1	0				
Utah:	Salt Lake City	29	2	0	1	11	59	11	59	11
Vt:	Barre	20	3	0	1	6	118	6	118	8
Va:	Richmond	16	0	0	0	2	44	2	44	1
Wash:	Seattle	9	0	0	0	5	27	(b)		
	Spokane	20	2	0	0	0				
W. Va:	Charleston	20	1	0	1	16	128	16	128	11
Wisc:	Madison	21	1	0	0	11	221	11	221	11
Wyo:	Cheyenne	9	1	0	1	0				
Network summary		973	9	0	0	194	118	6	100	5

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Air Surveillance Network, April 1973

National Environmental Research Center—Las Vegas,[1] Environmental Protection Agency

The Air Surveillance Network[2] (ASN), operated by the National Environmental Research Center—Las Vegas (NERC-LV), consists of 49 active and 73 standby sampling stations located in 21 western States (figures 2 and 3). The Network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), and at any other designated test-

[1] Formerly the Western Environmental Research Laboratory.

[2] The ASN is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

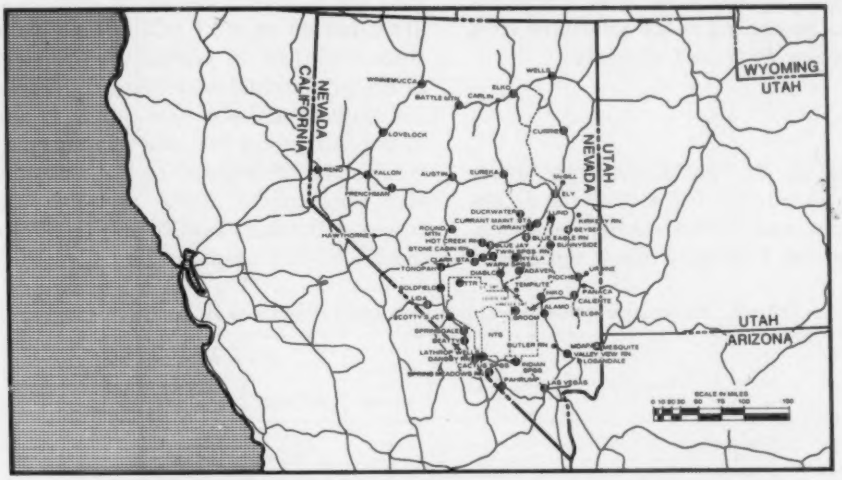

Figure 2. NERC-LV Air Surveillance Network stations in Nevada

Figure 3. NERC-LV Air Surveillance Network stations outside Nevada

ing sites.

The stations are operated by State health department personnel and by private individuals on a contract basis. All active stations are operated continuously with filters being exchanged over periods generally ranging from 24 to 72 hours. All samples are mailed to the NERC-LV unless special retrieval is arranged at selected locations in response to known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 2 presents the monthly average gross beta concentrations in air for each of the active network stations and of the standby stations, which are operated 1 week to check equipment operability. The highest gross beta concentration within the network was less than 0.2 pCi/m³ at Joplin, Mo.; Duckwater, Blue Eagle Ranch, and Reno, Nev.; and Delta, Utah. The minimum reporting concentration for gross beta is 0.1 pCi/m³. For averaging purposes, individual concentrations which are below the minimum detectable concentration (0.06 pCi/m³) are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reporting level (0.1 pCi/m³) are reported as <0.1 pCi/m³. No radionuclides were identified by gamma spectrometry on any filters or charcoal cartridges during April.

Complete copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC-LV upon written request.

Table 2. Summary of gross beta radioactivity concentrations in air, April 1973

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average ᵃ
Ariz:	Kingman	30	<0.1	<0.1	0.1
	Phoenix	7	<.1	<.1	<.1
	Seligman	30	<.1	<.1	<.1
	Winslow	8	<.1	<.1	<.1
Ark:	Little Rock	4	<.1	<.1	<.1
Calif:	Baker	26	.1	<.1	.1
	Barstow	30	<.1	<.1	<.1
	Bishop	28	.1	<.1	.1
	Death Valley Junction	29	.1	<.1	.1
	Furnace Creek	30	.1	<.1	.1
	Indio	8	<.1	<.1	<.1
	Lone Pine	28	.1	<.1	.1
	Needles	25	<.1	<.1	<.1
	Ridgecrest	30	<.1	<.1	<.1
	Shoshone	30	.1	<.1	.1
Colo:	Denver	5	<.1	<.1	<.1
	Durango	7	<.1	<.1	<.1
Idaho:	Boise	6	<.1	<.1	<.1
	Idaho Falls	4	<.1	<.1	<.1
	Preston	8	<.1	<.1	<.1
	Twin Falls	8	<.1	<.1	<.1
Iowa:	Iowa City	5	<.1	<.1	<.1
	Sioux City	7	<.1	<.1	<.1
La:	Lake Charles	5	<.1	<.1	<.1
	Monroe	5	<.1	<.1	<.1
	New Orleans	5	<.1	<.1	<.1
Mo:	Clayton	4	<.1	<.1	<.1
	Joplin	8	<.2	<.1	.1
	St. Joseph	8	<.1	<.1	<.1
Nebr:	North Platte	7	<.1	<.1	<.1
Nev:	Alamo	30	.1	<.1	.1
	Austin	21	.1	<.1	.1
	Battle Mountain	7	<.1	<.1	<.1
	Beatty	29	.1	<.1	.1
	Blue Eagle Ranch (Currant)	28	<.2	<.1	.1
	Blue Jay	30	<.1	<.1	<.1
	Caliente	30	<.1	<.1	<.1
	Currant Ranch	21	<.1	<.1	<.1
	Currie	8	<.1	<.1	<.1
	Diablo	30	<.1	<.1	<.1
	Duckwater	26	<.2	<.1	.1
	Elko	8	<.1	<.1	<.1
	Ely	30	<.1	<.1	<.1
	Eureka	30	<.1	<.1	<.1
	Fallini's Twin Springs Ranch	30	.1	<.1	.1

See footnotes at end of table.

Table 2. Summary of gross beta radioactivity concentrations in air April 1973—continued

Location		Number of samples	Concentration (pCi/m^3)		
			Maximum	Minimum	Average [a]
Nev:	Fallon	7	<0.1	<0.1	<0.1
	Frenchman Station	8	<.1	<.1	<.1
	Geyser Maintenance Station	30	<.1	<.1	<.1
	Goldfield	29	<.1	<.1	<.1
	Groom Lake	21	.1	<.1	.1
	Hiko	29	.1	<.1	.1
	Indian Springs	30	<.1	<.1	<.1
	Las Vegas	21	<.1	<.1	<.1
	Lathrop Wells	30	<.1	<.1	<.1
	Lida	30	<.1	<.1	<.1
	Lund	30	<.1	<.1	<.1
	Mesquite	30	<.1	<.1	<.1
	Nyala	30	<.1	<.1	<.1
	Pahrump	27	<.1	<.1	<.1
	Pioche	27	<.1	<.1	<.1
	Reno	7	<.2	<.1	.1
	Round Mountain	30	<.1	<.1	<.1
	Scotty's Junction	30	<.1	<.1	<.1
	Stone Cabin Ranch	30	<.1	<.1	<.1
	Sunnyside	30	<.1	<.1	<.1
	Tonopah	30	<.1	<.1	<.1
	Tonopah Test Range	28	.1	<.1	.1
	Warm Springs	30	<.1	<.1	<.1
	Warm Springs Ranch	30	<.1	<.1	<.1
	Wells	7	<.1	<.1	<.1
	Winnemucca	8	<.1	<.1	<.1
N. Mex:	Albuquerque	5	<.1	<.1	<.1
	Carlsbad	6	<.1	<.1	<.1
Okla:	Muskogee	7	<.1	<.1	<.1
Oreg:	Medford	8	<.1	<.1	<.1
S. Dak:	Aberdeen	8	<.1	<.1	<.1
	Rapid City	6	<.1	<.1	<.1
Tex:	Abilene	6	<.1	<.1	<.1
	Amarillo	5	<.1	<.1	<.1
	Austin	5	<.1	<.1	<.1
	Fort Worth	7	<.1	<.1	<.1
Utah:	Bryce Canyon	7	<.1	<.1	<.1
	Cedar City	30	<.1	<.1	<.1
	Delta	30	<.2	<.1	<.1
	Dugway	8	<.1	<.1	.1
	Enterprise	7	<.1	<.1	<.1
	Garrison	30	<.1	<.1	<.1
	Logan	7	<.1	<.1	<.1
	Milford	28	<.1	<.1	<.1
	Monticello	4	<.1	<.1	<.1
	Parowan	7	<.1	<.1	<.1
	Provo	2	<.1	<.1	<.1
	Roosevelt	7	<.1	<.1	<.1
	Salt Lake City	7	<.1	<.1	<.1
	St. George	30	<.1	<.1	<.1
	Wendover	7	<.1	<.1	<.1
Wash:	Spokane	5	<.1	<.1	<.1
Wyo:	Rock Springs	8	<.1	<.1	<.1
	Worland	7	<.1	<.1	<.1

[a] Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reportable value of 0.1 pCi/m^3 is reported as <0.1.

3. Canadian Air and Precipitation Monitoring Program,[1] April 1973

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 4), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

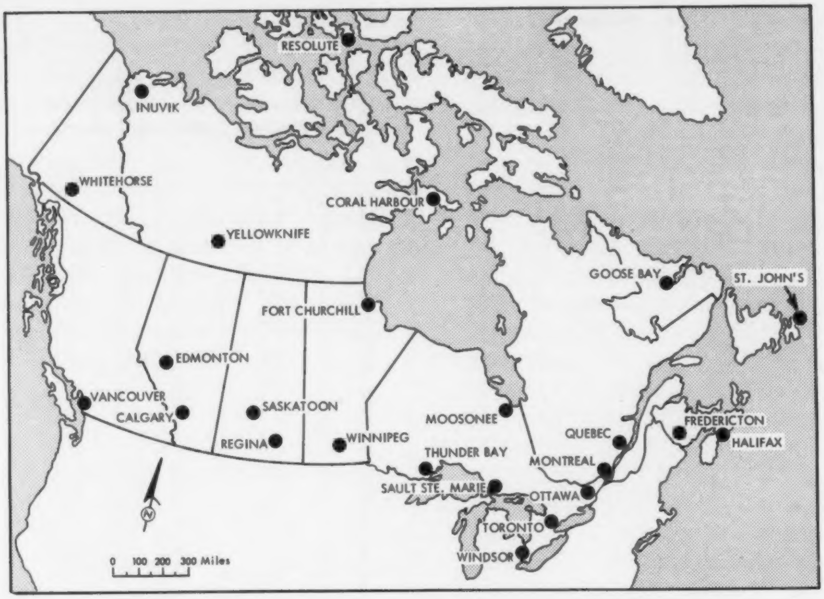

Figure 4. Canadian air and precipitation monitoring program

Table 3. Canadian gross beta radioactivity in surface air and precipitation, April 1973

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	5	0.01	0.01	0.01	25	0.7
Coral Harbour	5	.03	.01	.02	NS	NS
Edmonton	5	.02	.01	.01	11	.5
Ft. Churchill	5	.03	.01	.02	13	.1
Fredericton	5	.02	.01	.02	6	.7
Goose Bay	5	.02	.01	.01	NS	NS
Halifax	5	.03	.01	.02	7	.8
Inuvik	4	.03	.02	.02	36	.3
Montreal	5	.02	.01	.02	9	.6
Moosonee	4	.03	.02	.03	5	.2
Ottawa	5	.02	.01	.01	3	.3
Quebec	5	.02	.01	.01	8	.6
Regina	5	.02	.01	.01	16	.9
Resolute	5	.03	.02	.03	81	.1
St. John's, Nfld	3	.02	.01	.01	13	.6
Saskatoon	5	.02	.01	.02	14	.8
Sault Ste. Marie	5	.03	.01	.02	14	.8
Thunder Bay	5	.02	.01	.02	11	.4
Toronto	2	.02	.01	.02	12	.8
Vancouver	3	.01	.01	.01	42	.5
Whitehorse	5	.01	.01	.01	19	.2
Windsor	4	.02	.01	.01	17	.6
Winnipeg	5	.02	.01	.02	37	.8
Yellowknife	5	.02	.01	.01	47	.4
Network summary	110	0.03	0.01	0.02	20	0.5

NS, no sample available.

1969 issue of *Radiological Health Data and Reports*.

Surface air and precipitation data for April 1973 are presented in table 3.

4. Pan American Air Sampling Program April 1973

Pan American Health Organization and U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The April 1973 air monitoring results from the participating countries are given in table 4.

Figure 5. Pan American Air Sampling Program stations

Table 4. Summary of gross beta radioactivity in Pan American surface air, April 1973

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average [a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	15	0.02	0.00	0.01
Chile:	Santiago	15	.03	.00	.02
Colombia:	Bogota	17	.04	.00	.01
Ecuador:	Cuenca	6	.05	.00	.01
	Guayaquil	14	.06	.00	.01
	Quito	2	.00	.00	.00
Guyana:	Georgetown	9	.02	.00	.00
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	8	.05	.00	.01
West Indies:	Trinidad	9	.07	.03	.05
Pan American summary		105	0.07	0.00	0.01

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging 0.00 pCi/m³.

5. California Air Sampling Program April 1973

Bureau of Radiological Health
California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 6.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a continuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2 cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 5 presents the monthly gross beta radioactivity in air for April 1973. The monthly sample results are presented quarterly.

Table 5. Gross beta radioactivity in California air April 1973

Station location	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Bakersfield	30	0.89	0.01	0.20
Barstow	30	.87	.01	.14
Berkeley	30	.66	.00	.08
El Centro	30	.81	.04	.13
Eureka	26	.20	.00	.04
Fresno	28	.86	.00	.18
Los Angeles	30	.35	.00	.08
Redding	27	.15	.00	.07
Sacramento	30	.47	.02	.09
Salinas	29	5.65	.04	.50
San Bernardino	28	.45	.00	.11
San Diego	30	.26	.03	.07
San Luis Obispo	20	.59	.00	.11
Santa Rosa	30	.22	.00	.07
Summary	398	5.65	0.00	0.13

Figure 6. California air sampling program stations

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Fallout in the United States and Other Areas [1] January–December 1971

Health and Safety Laboratory
Atomic Energy Commission

Monthly fallout deposition rates for strontium-90 are determined by the Health and Safety Laboratory (HASL) for 33 sites in the United States and 90 locations in other countries. HASL data from all of the active United States stations and other selected points in the Western Hemisphere (figure 1) covering the period from January–December 1971 are summarized in tables 1 and 2. All the stations of the 80th Meridian Network are represented.

Methods of collection

Two methods of fallout collection are employed by HASL. In the first, precipitation and dry fallout are collected for a period of 1 month in a stainless-steel pot with an exposed area of 0.076 m^2. At the end of the collection period, the contents are transferred, by careful scrubbing with a rubber spatula, to a polyethylene sample bottle which is then shipped to the laboratory for analysis.

The second method involves the use of a polyethylene funnel, with an exposed area of 0.072 m^2, attached to an ion exchange column. After a 1-month collection, the inside of the funnel is wiped with a tissue, and the tissue is inserted in the end of the column, which is then sealed and sent to HASL for analysis. It has been shown that at the 95-percent confidence level there was no significant difference in the strontium-90 measurements obtained from samples collected by the two methods (*1*).

[1] The data in this article were taken from "Fallout Program Quarterly Summary Report," HASL–273: A–1 to A–310.

REFERENCE

(*1*) ONG, L. D. Y. Homogeneity between pot and ion exchange column strontium-90 measurements. Fallout Program Quarterly Summary Report, HASL–135: 256–269. Office of Technical Services, Department of Commerce, Washington, D.C. (April 1, 1963).

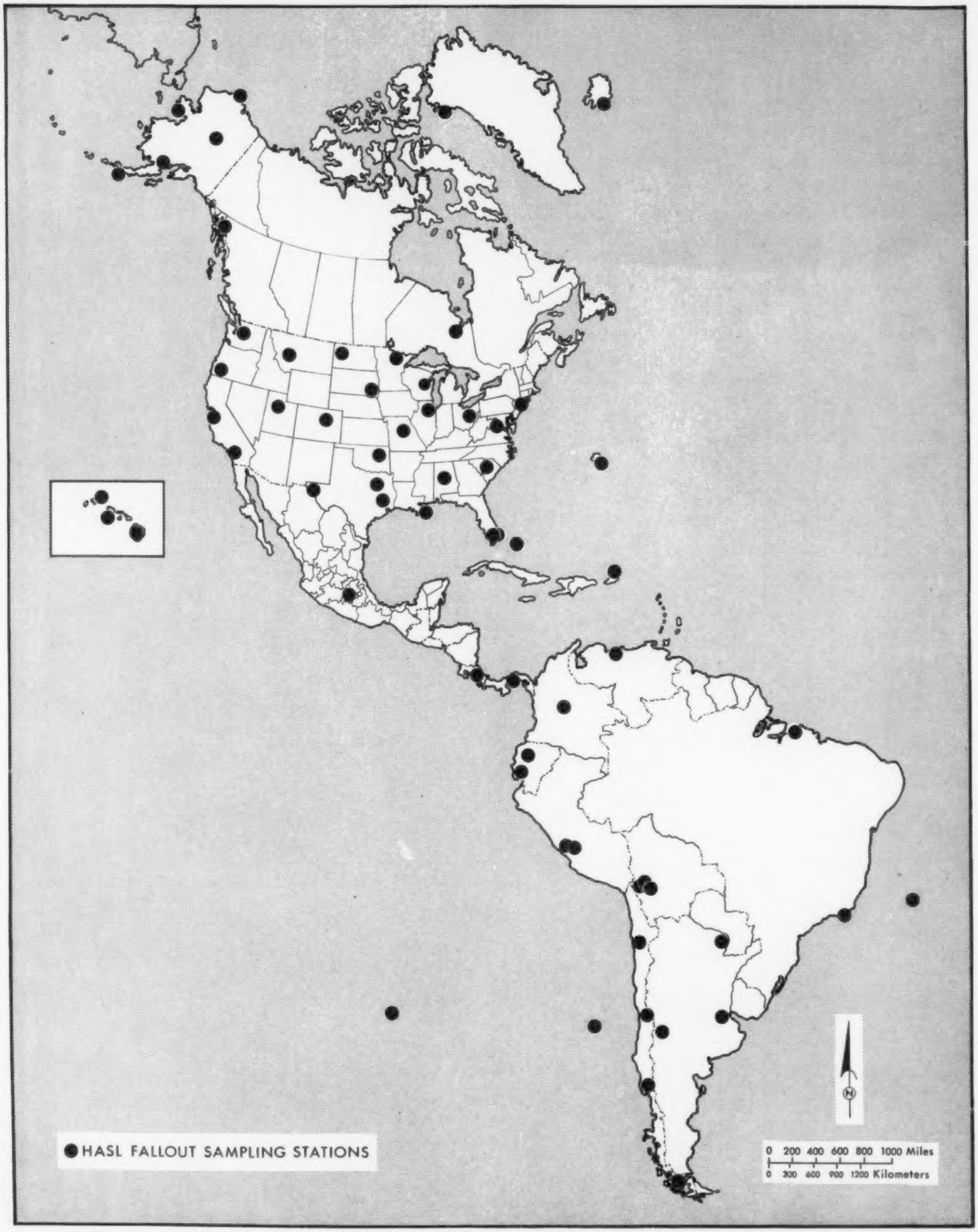

Figure 1. HASL fallout sampling stations in the Western Hemisphere

Table 1. Strontium-90 fallout in the United States, HASL, January–December 1971

Sampling location		Type of collection	Deposition (nCi/m²)											
			Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ala:	Birmingham	pot	0.06	(b)	0.21	0.15	(b)	0.53	0.24	0.07	0.02	0.02	0.03	0.05
Alaska:	Anchorage	column	(a)	0.07	(a)	.03	.02	.08	.35	(a)	(a)	.05	.02	.02
	Cold Bay	column	.01	.03	(a)	.02	.10	.07	.04	.09	.09	.05	.04	.07
	Fairbanks	column	.01	(b)	.01	(b)	(a)	.07	.19	(b)	(b)	(b)	(b)	(b)
	Juneau	column	.09	.10	.02	.09	.09	.06	.09	.14	.02	.10	.04	.02
	Nome	column	(a)	(a)	(a)	(a)	.05	.11	.08	(b)	(b)	.05	(a)	(a)
Calif:	W. Los Angeles	pot	(a)	.02	.03	(b)	.05	.02	(a)	(a)	(a)	(a)	(a)	.08
	San Francisco	column	.04	[c].04	[c].04	.06	.06	.02	(a)	(a)	(a)	(a)	.02	.06
Colo:	Denver	column	(a)	.02	(a)	[c].15	[c].14	.28	.09	.05	.08	(a)	(a)	.02
Fla:	Coral Gables	pot	(a)	(a)	.03	.05	.08	.34	(b)	(b)	(b)	(b)	(b)	(b)
	Miami	column	.02	.02	.02	.04	.10	.26	.12	.08	.05	.05	.01	(b)
Hawaii:	Honolulu	pot	.23	(b)	(b)	(b)	(b)	.22	.10	(b)	.05	.02	.14	.10
	Lihue	column	.08	[c].13	[c].13	.08	.06	.10	.07	.04	.04	.02	.02	.03
	Mauna Loa	column	.02	.01	.01	.14	.05	.04	.02	(a)	.01	(a)	(a)	(a)
Ill:	Argonne	pot	.03	.05	.11	.10	.35	.24	.20	.11	.06	.02	.05	.04
La:	New Orleans	column	.01	.07	.13	.10	.08	.31	.10	.05	.04	(a)	(a)	(a)
Minn:	International Falls	column	(a)	.02	.02	.07	.24	.74	.26	.09	.09	.06	.02	(a)
Mo:	Columbia	column	(a)	.08	.03	.18	.24	.14	.22	.05	.08	.03	.04	.06
Mont:	Helena	column	.02	.03	.01	.07	.21	.22	.16	.10	.05	.02	(a)	(a)
N.Y:	New York City	pot	.04	.12	.18	.14	.30	.13	.20	.10	.06	.04	.06	.04
N. Dak:	Williston	column	.01	.01	.01	.12	.45	.56	.23	.06	.11	.02	(a)	(a)
Ohio:	Wooster	pot	.03	.08	.03	.05	.18	.26	.09	.05	.02	.02	.04	.01
Okla:	Tulsa	pot	(a)	.08	.02	.21	.43	.31	.18	.04	.25	.06	.04	.08
Oreg:	Medford	column	.03	[c].02	[c].02	.06	.11	.08	.04	.04	.03	.02	.02	.02
S.C:	Columbia	column	(b)	.17	.09	.15	.13	[c].12	[c].12	.10	.01	(a)	.02	.02
S. Dak:	Vermillion	pot	(a)	.15	.09	.25	.27	.72	.28	.04	.06	.06	.03	(a)
Tex:	Dallas	column	.01	[c].04	[c].04	.28	.28	.08	.10	.04	.02	.03	.03	.04
	El Paso	column	.02	.02	(a)	.16	(a)	.02	.09	.11	.04	.03	(a)	(a)
	Houston	column	.02	.03	.04	.11	.17	.04	.06	.09	.04	.02	.02	.04
Utah:	Salt Lake City	pot	.04	.09	.09	.36	.46	.36	.05	.06	.04	.10	.08	.04
Va:	Sterling	column	.05	.11	.04	.11	.27	.16	.09	.09	.03	.02	.02	(a)
Wash:	Forks	column	.22	.19	.33	.31	.22	.22	.10	.08	.06	.12	.03	(a)
Wisc:	Green Bay	column	.03	.03	.04	.16	.18	.18	[c].23	.23	.05	(a)	.03	.02

[a] Zero or trace.
[b] Data not available.
[c] Proportioned from originally consolidated data.

Table 2. Strontium-90 fallout in North and South America, HASL, January–December 1971

Sampling location		Type of collection	Deposition (nCi/m²) Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Argentina:	Buenos Aires	column	0.07	0.16	0.05	0.03	0.07	0.04	0.09	0.04	0.21	0.16	0.07	0.17
	Formosa	column	.04	.06	.03	([a])	([a])	.06	.03	.18	.15	.12	.02	.05
	Malargue	column	.02	.04	.04	.02	.01	.02	.04	.12	.01	.02	([a])	.04
Bahama	Bimini	column	.02	.03	.02	.03	.25	.12	.07	.04	.03	([b])	([b])	([b])
Bermuda:	Kindley AFB	column	.08	.02	.17	.16	.19	.19	.07	.10	.05	.13	([b])	([b])
Bolivia:	Chacaltaya	column	([a])	([a])	([a])	([a])	([a])	([a])	([a])	([a])	([a])	.02	.03	.01
	La Paz (city)	column	.02	.01	.01	([a])	([a])	([a])	([a])	([a])	.03	.02	.02	.02
	La Paz (Ovejuyo)	column	([a])	.02	([a])	.02	([a])	([a])	([a])	([a])	([a])	([a])	([a])	.01
Brazil:	Belem	column	.03	.02	.03	.02	.02	.04	.04	.02	.07	.07	([a])	.03
	Rio de Janeiro	column	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])
	Trindade Island	column	.03	.01	.01	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])
Canada:	Moosonee	column	([a])	.02	([a])	.07	.12	.23	.36	.16	.04	.09	.01	([a])
Chile:	Antarctica	column	([b])	.03	.05	.03	([a])	([a])	([a])	.02	([a])	.04	.02	.01
	Antofagasta	column	([a])	([a])	([b])	([a])	([b])	([a])	([a])	([a])	([b])	([b])	([b])	([a])
	Conception	column	([b])	([b])	([b])	([b])	.08	.12	.25	.09	.14	.03	([b])	([b])
	Easter Island	column	.04	.06	([a])	.04	.07	.03	.07	.04	.08	.08	.05	.06
	Puerto Montt	column	.12	.10	.09	.09	([b])	.09	.24	([b])	.15	.08	.13	.18
	Punta Arenas	column	([a])	.04	([b])	([a])	.02	.02	.02	.08	.08	.04	([a])	([b])
	Santiago	pot	.01	([a])	([a])	([a])	.02	.09	.02	.07	.03	.07	([a])	([a])
	Santiago	column	.01	([a])	([a])	.01	.02	.08	.17	.04	.03	.07	.01	.05
	Temuco	column	.11	[c].04	[c].04	[c].04	.07	.10	.26	.11	.09	([b])	([b])	([b])
Colombia:	Bogota	pot	([b])	([b])	.02	([a])	([a])	([b])	([b])	([a])	([a])	([a])	([a])	([a])
Costa Rica:	Turrialba	column	([a])	([a])	.05	.07	.04	.09	.09	.04	([a])	.02	.02	.01
Equador:	Guayaquil	column	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])
	Quito	column	([a])	.01	([a])	([a])	([a])	([a])	([a])	([a])	([a])	.01	.01	([a])
Greenland:	Thule	column	([b])	([a])	([a])	.01	([a])	.04	.03	.08	.02	([a])	([a])	.03
Iceland:	Keflavik	column	([b])	.05	.06	.10	.13	.04	.11	.11	.05	.05	.03	.06
Mexico:	Mexico City	column	([a])	.02	([a])	.03	.05	([a])	([b])	.04	([a])	.01	([a])	([a])
Peru:	Lima	column	([a])	([a])	([b])	([a])	([a])	.04	([a])	.02	([a])	.01	.02	.01
Puerto Rico:	San Juan	column	.01	([b])	([b])	.23	([b])	.14	[c].06	[c].07	.02	.04	.01	([a])
Venezuela:	Caracas (site 1)	column	([a])	([a])	([a])	([a])	.03	.04	([b])	.04	.01	.01	([b])	([a])
	Caracas (site 2)	column	([b])	([b])	([b])	.03	([b])	([b])	([b])	([b])	.01	([b])	([b])	([b])

[a] Zero or trace.
[b] Data not available.
[c] Indicates proportioned from originally consolidated data.

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors annual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of the environmental radioactivity data follows for Atomics International.

[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation," contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Atomics International[2] January–December 1971

North American Rockwell Corporation
Canoga Park, Calif.

Atomics International, a division of North American Rockwell Corporation, has engaged in atomic energy research and development since 1946. The company designs, develops, and constructs nuclear reactors for central station and compact power plants for medical, industrial, and scientific applications.

The company headquarters is located in Canoga Park, Calif., approximately 23 miles northwest of downtown Los Angeles. The 290-acre Nuclear Development Field Laboratory (Santa Susana Facility), equipped with extensive testing facilities for the support of advanced nuclear studies, is located in the Simi Hills of Ventura County, approximately 29 miles northwest of downtown Los Angeles. The location of the above sites in relation to nearby communities is shown in figure 1.

The basic concept of radiological hazard control at Atomics International requires adequate containment of radioactive materials and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a measure of the effectiveness of the company's radiological safety procedures and of engineering safeguards incorporated into facility designs.

The onsite environs of Atomics International headquarters and Nuclear Development Field Laboratory (NDFL) are surveyed monthly to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The offsite environs are sampled monthly, except for soil and vegetation which

[2] Summarized from "Environmental Monitoring, Annual Report, January 1, 1971 to December 31, 1971," Atomics International, Division of North American Rockwell Corporation.

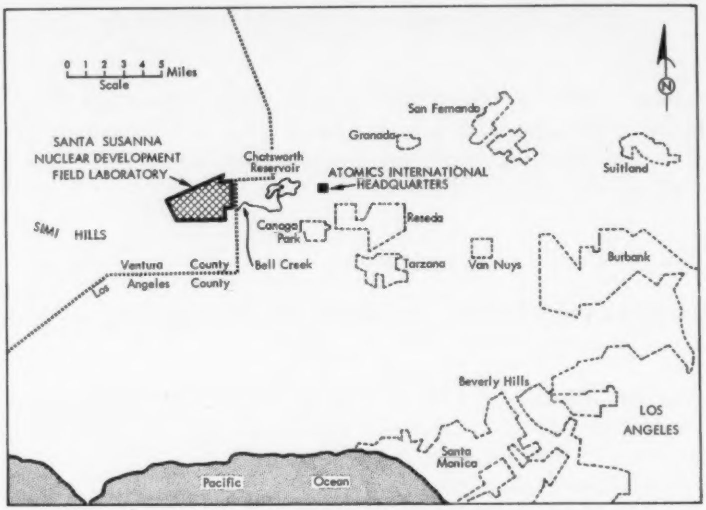

Figure 1. Atomics International facilities and vicinity

are sampled quarterly. Continuous environmental air monitoring at the sites provides information concerning long-lived airborne particulate radioactivity. A site perimeter radiation monitoring program using thermoluminescent dosimetry (TLD) was begun in 1971.

Counting and calibration procedures

The determination of radioactivity in all environmental soil, vegetation, water, and air samples is performed with a low-background proportional counting system capable of simultaneous counting of both alpha and net beta radioactivity. The sample-detector configuration provides a nearly 2π geometry. The thin-window detector is continually purged with methane counting gas. A preset time mode of operation is used for all samples; however, an overriding preset count mode is available to limit the counting time for high activity samples.

The minimum detection limits shown in table 1 were determined by using typical values for counting time, system efficiency, background count rates (approximately 0.05 cpm alpha and 1.0 cpm beta-gamma) and sample size. In addition, the minimum statistically significant amount of radioactivity, irrespective of sample

Table 1. Minimum radioactivity detection limits Atomic International, January–December 1971

Sample	Type of radioactivity	Minimum detection limits (standard error)
Soil	Alpha	0.05 ± 0.03 (pCi/g)
	Beta-gamma	.22 ± .11 (pCi/g)
Vegetation	Alpha	.10 ± .06 (pCi/g-ash)
	Beta-gamma	.35 ± .18 (pCi/g-ash)
Water	Alpha	.20 ± .12 (pCi/liter)
	Beta-gamma	.63 ± .32 (pCi/liter)
Air	Alpha	8.5 ± 5.3 (fCi/m^3)
	Beta-gamma	18 ± 9.3 (fCi/m^3)

configuration, is established as that amount equal in count rate to three times the standard deviation of the system background count rate.

Counting system efficiencies are determined routinely with RaD+E+F (with alpha absorber), thorium-230, and uranium-235 standard sources, and with potassium-40 in the form of standard reagent grade KCl, which is used to simulate soil and vegetation samples. Self-absorption standards are made by dividing sieved KCl into samples beginning with a 100 milligram sample and increasing in mass by 200-milligram increments from 200 to 3,000 milligrams. The samples are placed in copper planchets of the type used for environmental samples and counted. The ratio of sample activity to the observed net count for each sample is plotted as a function of sample weight (figure 2). The correction factor (ratio) corre-

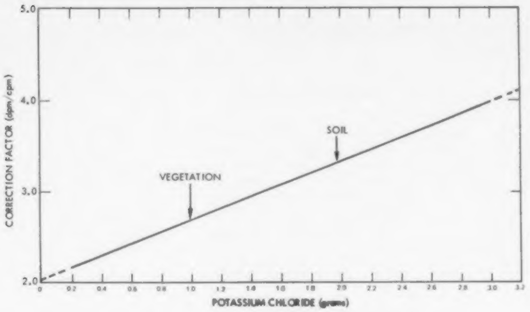

Figure 2. Sample self-absorption graph

sponding to sample weight is obtained from the graph. The product of the correction factor and the net sample count rate yields the sample activity (dpm). This method has been proved usable by applying it to variously sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fall within the expected statistical counting error.

Air monitoring

Environmental air sampling is conducted continuously at the headquarters and NDFL sites with automatic sequential air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV-70 filter paper which is automatically changed at the end of each sampling period. The filter is removed from the sampler and counted after the radioactivity is allowed to decay for at least 72 hours. The volume of a typical daily environmental air sample is approximately 20 cubic meters. The average concentration of long-lived beta-gamma radioactivity on airborne particulates is presented in table 2.

Table 2. Radioactivity in air, Atomics International January–December 1971

Location	Type of radioactivity	Number of samples	Average concentration (fCi/m^3)
Headquarters	Alpha	730	8.7
	Beta-gamma	730	300
NDFL	Alpha	2,476	8.6
	Beta-gamma	2,476	330

When abnormally high airborne radioactivities are observed, the beta-gamma radioactivity decay data are plotted to determine the presence of short-lived isotopes other than naturally occurring radon, thoron, and daughters. If fallout is suspected, the decay characteristics are observed. If the radioactivity decays as a function of $t^{-1.2}$, the data curve is extrapolated in order to determine the date of origin. This data is compared with the dates of publicized nuclear detonations to determine if the abnormal airborne radioactivity was caused by such detonations.

Water monitoring

Process water used at the NDFL is obtained from Ventura County Water District No. 10 and distributed onsite by the same piping system previously used when process water was supplied by onsite wells. Pressure is provided by elevated storage tanks, one 50,000-gallon and one 500,000-gallon tank onsite. While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the pipe system is sampled monthly at two locations. The average process water radioactivity concentration is presented in table 3.

Table 3. Process water radioactivity, NDFL site January–December 1971

Type of radioactivity	January-June 1971		July-December 1971	
	Number of samples	Average concentration (pCi/liter)	Number of samples	Average concentration (pCi/liter)
Alpha	12	0.32	12	0.24
Beta-gamma	12	4.9	12	4.8

Surface discharged waters from NDFL facilities drain into holding reservoirs on adjacent Santa Susana Field Laboratory (SSFL) property. When full, the main reservoir is drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66–49, an environmental sampling station has been established in Bell

Table 4. Radioactivity in the Rocketdyne reservoir and Bell Creek[a] January–December 1971

Sample description	January-June 1971			July-December 1971		
	Number of samples	Alpha radioactivity	Beta-gamma radioactivity	Number of samples	Alpha radioactivity	Beta-gamma radioactivity
Reservoir (station 6), water [a] (pCi/liter)	6	0.23	6.1	6	0.12	6.2
Reservoir (station 12), water [a] (pCi/liter)	6	.15	6.2	6	.17	6.5
Bell Creek (station 54), mud (pCi/g)	6	.31	23	6	.40	23
Bell Creek (station 54), vegetation (pCi/g ash)	6	.19	161	6	.20	96
Bell Creek (station 16), water (pCi/liter)	6	.21	3.9	6	.10	3.7

[a] Location not shown on figure 1.

Creek Canyon approximately 2.5 miles downstream from the south NDFL boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in the main holding reservoir and Bell Creek samples are presented in table 4.

Soil, vegetation, and water are sampled monthly at Chatsworth Reservoir which is owned and operated by the Los Angeles City Department of Water and Power. Normally, one water sample is obtained from the lake surface and a second sample is obtained from the reservoir water supply inlet located on the north side of the lake. The lake was drained in July 1969 for construction, thereby precluding surface sampling for the current reporting period. The average radioactivity concentration in reservoir supply water samples is presented in table 5.

Soil and vegetation monitoring

Soil and vegetation are regularly sampled at 25 locations. Eleven sampling stations are located within the boundaries of Atomics International's sites and are referred to as "onsite" stations. The remaining 14 stations, located within a 10-mile radius of sites, are referred to as "offsite" stations.

Surface soil types available for sampling range from decomposed granite to clay loam. Samples are taken from the top half-inch layer of undisturbed ground surface. The soil samples are packaged and sealed in plastic containers and returned to the laboratory for analysis. Radioactivity in soil samples is presented in table 6.

Vegetation samples obtained in the field are of the same plant type wherever possible, generally, sunflower or wild tobacco plant leaves.

Table 5. Chatsworth Reservoir water radioactivity, Atomics International January–December 1971

Sample	Type of radioactivity	January-June 1971		July-December 1971	
		Number of samples	Average concentration (pCi/liter)	Number of samples	Average concentration (pCi/liter)
Lake surface	Alpha	0	—	0	—
	Beta-gamma	0	—	0	—
Supply inlet	Alpha	6	0.48	2	0.26
	Beta-gamma	6	6.1	2	6.3

Table 6. Radioactivity in the soil, Atomics International January–December 1971

Area	Type of radioactivity	January-June 1971		July-December 1971	
		Number of samples	Average concentration (pCi/g)	Number of samples	Average concentration (pCi/g)
Onsite	Alpha	72	0.57	72	0.55
	Beta-gamma	72	25	72	25
Offsite	Alpha	24	.55	24	.50
	Beta-gamma	24	24	24	23

These types maintain a more active growth rate during the dry season than do most natural vegetation indigenous to the local area. Vegetation leaves are stripped from plants and transferred to the laboratory for analysis. Plant root systems are not routinely sampled. Radioactivity in vegetation samples is presented in table 7.

External radiation

Site boundary radiation monitoring is performed with calcium fluoride thermoluminescent dosimeters (TLD) placed at selected locations on or near the perimeters of the Headquarters and NDFL sites. Each dosimeter, sealed in a lightproof plastic holder, is installed in a polyethylene vial which is permanently mounted at each monitoring location. The dosimeters are exchanged and analyzed quarterly. The radiation dose monitored at each dosimeter location is presented in table 8.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
January–June 1971	February 1972

Table 8. External radiation dose, Atomics International January–December 1971

Location	January-June 1971		July-December 1971 [a]	
	Dose (mrem)	Average dose rate (μrem/h)	Dose (mrem)	Average dose rate (μrem/h)
TLD-1	97	24	102	44
TLD-2	67	16	80	34
TLD-3	90	22	42	18
TLD-4	99	24	416	179
TLD-5	81	20	42	18
TLD-6	84	21	32	14
TLD-7	99	24	48	21
TLD-8	108	27	51	22
TLD-9	[b] 39	18	35	15
TLD-10	132	32	42	18

[a] Fourth quarter only, TLD reader malfunction resulted in anamolous data.
[b] Second quarter only.

Table 7. Radioactivity in vegetation, Atomics International January–December 1971

Area	Type of radioactivity	January-June 1971		July-December 1971	
		Number of samples	Average (pCi/g-ash)	Number of samples	Average (pCi/g-ash)
Onsite	Alpha	72	0.25	72	0.20
	Beta-gamma	72	165	72	164
Offsite	Alpha	24	.26	24	.34
	Beta-gamma	24	134	24	130

Reported Nuclear Detonations, July 1973

(Includes seismic signals presumably from foreign nuclear detonations)

Seismic signals, presumably from a Soviet underground nuclear explosion, were recorded by the United States on July 9, 1973. The signals originated at the Semipalatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the yield range of 20–200 kilotons.

Seismic signals from a Soviet underground nuclear test in the yield range of 200 kilotons to 1 megaton were recorded by the United States on July 22, 1973. The signals originated at about 9:23 p.m., e.d.t. in the Semipalatinsk nuclear test area of the Soviet Union.

There were no reported nuclear detonations for the United States for July 1973.

Not all of the nuclear detonations in the United States are announced immediately, therefore, the information in this section may not be complete. A complete list of announced U.S. nuclear detonations may be obtained upon request from the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

THE POTENTIAL EYE EXPOSURE TO PERSONNEL USING FLUOROSCOPIC TECHNIQUES. *H. D. Maillie and W. D. Gregory. Radiation Data and Reports, Vol. 14,* August 1973, pp. 463–466

Measurements were made on a mockup to estimate the weekly exposure to the eyes of personnel working in the vicinity of a fluoroscope used in diagnostic radiology. A radiologist utilizing the image intensifier and protected by means of a lead drape and panel could receive 36 mR/week to the eyes whereas other individuals positioned away from this area, but in the vicinity of the table could receive up to 700 mR/week. The factors associated with these estimates, and the importance of wearing personnel monitors where they will estimate eye exposures are discussed.

Keywords: eye exposure, diagnostic radiology, fluoroscopy

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